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UNITED STATES
DEPARTMENT OF THE INTERIOR
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INFORMATION CIRCULAR

DESIGN AND OPERATION OF THE COAL PLANER
RUHR DISTRICT, GERMANY

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JOHN W. BUCH

FOREWORD

This report is one of a series written by members of the Solid Fuels Mission to Germany describing wartime developments in the mining, preparation, and utilization of coal. This mission was organized early in 1945 under the auspices of the Technical Industrial Intelligence Committee, which cooperated with a counter-part British committee. In some instances, engineers from other allied countries cooperated. The Solid Fuels Mission operated under the direction of a steering committee headed by Dr. C. J. Potter, Deputy Solid Fuels Administrator. The personnel of the mission consisted of H. F. Yansey, in charge, J. W. Buch, Thomas Fraser, L. L. Newman, and L. D. Schmidt of the Bureau of Mines; H. H. Lowry, Director of the Coal Research Laboratory, Carnegie Institute of Technology; H. J. Rose, Vice-President and Director of Research, Bituminous Coal Research, Inc.; and F. H. Reed, Chief Chemist, Illinois Geological Survey.

Over 50 reports were written by the members of the Solid Fuels Mission. These, together with microfilms of supporting data obtained in the course of the investigations, are on file at the Bureau of Mines, Washington, D. C., where they are available for examination. The Office of the Publication Board in the Department of Commerce is prepared to furnish photolith copies, photostats, or microfilm reproductions of all declassified reports. A Bibliography of Scientific and Industrial Reports is issued weekly by the Department of Commerce, Office of the Publication Board, and is sold by the Superintendent of Documents, Government Printing Office, Washington 25, D. C., on a subscription basis. An initial payment of $10 will provide for approximately 9 months, and subscribers will be notified when additional remittance is necessary. All subscriptions will begin with volume 1, No. 1, unless ordered otherwise. The Bibliography covers all materials and subjects and gives instructions for obtaining the desired items.

The reports of the Solid Fuels Mission relate to the following general subjects: Mining methods in the Ruhr district of Germany, with special reference to mechanical cutting and loading equipment, pneumatic packing, and Diesel mine locomotives; activities of industrial research laboratories supported by the German coal and coke industry; coal preparation in Western Europe; low-temperature carbonization processes; metallurgical coke from weekly coking coals; low-ash electrode carbon from coal; new developments in the production of metallurgical coke and the utilization of gas and byproducts; briquetting brown coal and bituminous coal without the use of binders; recent engineering developments in gas turbines and steam generators, with special reference to use of coal; German coal-fired heating and cooking stoves; and the commercial extraction of coal with solvents for production of synthetic liquid fuels or chemical products.

Numerous reports on the activities of German synthetic liquid fuels plants and the plants for the production of synthesis gas from solid fuels are available in the same office as the solid fuels reports.

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It is planned to publish in this series of Bureau of Mines Information Circulars the more important reports or combination of reports prepared by the members of the Solid Fuels Mission. A similar series on synthetic liquid fuel activities is being prepared.

A. C. FIELDNER, Chief
Fuels and Explosives Branch.
Bureau of Mines
Washington, D. C.

I.C. 7377,
October 1946.

INFORMATION CIRCULAR

UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

DESIGN AND OPERATION OF THE COAL PLANER, RUHR DISTRICT, GERMANY[1][2]

By John W. Buch[3]

CONTENTS

Page
Conclusion.......... 3
Introduction.......... 3
Conventional mining methods.......... 5
  Flat mining.......... 5
  Steep-pitch mining.......... 6
Wartime developments in mining machinery for longwall work 7
  Schrämlader.......... 7
  Harmann scraper.......... 7
  Coal planer (Kohlenhobel).......... 7
  Standard design.......... 8
  Designs for planing hard bituminous coal.......... 9
Accessory equipment.......... 9
  Coal-planer hoists.......... 9
  Rope.......... 10
  Main-sheave mountings.......... 10
  Conveyors.......... 10
Methods of operation.......... 11
  Friedrich-Heinrich mine.......... 11
  Ibbenbüren mine.......... 12
Roof support.......... 12
Operating performance.......... 13
  Ibbenbüren mine.......... 13
  Friedrich-Heinrich mine.......... 13
Safety.......... 13
Patents.......... 17
Steep-pitch mining.......... 18
  Coal-planer design.......... 18
  Operation.......... 18
  Operating performance.......... 18
Acknowledgements.......... 20

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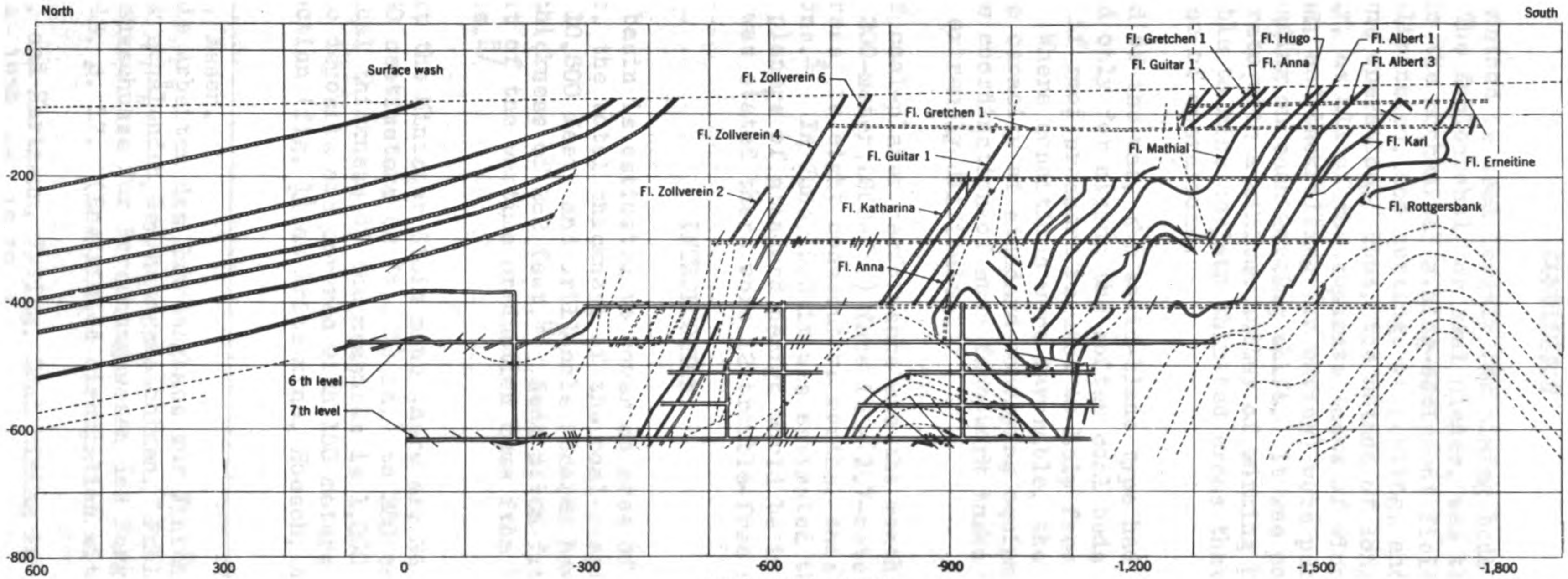
[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7377."

[2] Prepared from data obtained in July 1945 by the author as a member of the Solid Fuels Mission to the European Theater of Operations organized by the Technical Industrial Intelligence Committee of the Joint Chiefs of Staff.

[3] Mining engineer, Fuels and Explosives Branch, Bureau of Mines, Wilkes-Barre, Pa.

ILLUSTRATIONS

Fig.		Following page
1.	Cross section of coal measures, mine Fritz	2
2.	Plan of 6th level, mine Bruchstrasse	4
3.	Cross section of coal measure, mine Bruchstrasse	4
4.	Schwartz mine prop	6
5.	Hand-mining layout, steep pitch, mine Bruchstrasse	6
6.	Eickhoff Schrämlader	6
7.	Harmann scraper	6
8.	Longwall layout for Harmann scraper	6
9.	Face details, Harmann scraper	6
10a.	Hannover-Hannibal coal planer model, viewed from coal face	8
10b.	Hannover-Hannibal coal planer model, viewed from conveyor.	8
10c.	Hannover-Hannibal coal planer model, viewed from top, in direction of travel	8
10d.	Hannover-Hannibal coal planer model, viewed from underside, in direction of travel	8
11a.	Monopol planer, viewed from top in direction of travel	8
11b.	Monopol planer, side view	8
12.	Ibbenbüren coal planer	8
13a.	Friedrich-Heinrich coal planer	8
13b.	Friedrich-Heinrich coal planer blade	8
14.	Hannibal hewer	8
15.	Flottmann hewer	8
16.	Face layout, Monopol mine	10
17.	Face layout, Friedrich-Heinrich mine	10
18.	Face layout, Ibbenbüren mine	10
19a.	Coal planer and chain conveyor	10
19b.	Cross sections, chain conveyors	10
20.	Pneumatic rams for moving conveyor	10
21.	Sequence of cuts, Friedrich-Heinrich mine	10
22.	Pneumatic packing with coal planer, Friedrich-Heinrich mine	12
23a.	Saw-blade timbering with coal planer, Friedrich-Heinrich mine	12
23b.	Saw-blade timbering with coal planer, Friedrich-Heinrich mine	12
23c.	Saw-blade timbering with coal planer, Friedrich-Heinrich mine	12
23d.	Saw-blade timbering with coal planer, Friedrich-Heinrich mine	12
24.	German patent, 1912	16
25.	British patent, 1917	16
26.	German patent, 1922	16
27.	American patent, 1925	16
28.	French patent, 1927	16
29.	American patent, 1929	16
30.	German patent, 1935	16
31.	German patent, 1935	16
32.	Westhausen planer	18
33.	Face layout, coal planer on steep pitch, Westhausen mine	18
34.	Face layout, for Furtenhofer planer	18



Note: Elevations shown in meters

Figure I. - Cross section of coal measures, mine Fritz.

CONCLUSION

The longwall method is used largely for mining beds that pitch less than 30 degrees. The Kohlenhobel, or coal planer, was the outstanding wartime development in the mechanical mining-equipment field. With it, drilling and blasting are eliminated, and cutting, or peeling, and mechanical loading are performed in one operation. Thus, the method of longwall mining was changed drastically, as all of the separate tasks of winning, loading, moving conveyor, timbering, and backfilling (or caving) were performed simultaneously with continuous loading on each working shift. It was possible to maintain a high production rate with a minimum number of working places, and it became economically feasible to mine certain thin-bed areas that had been developed in the normal course of operations.

Before the end of the war, the solid-blade type had been standardized. This type is suited only for mining the softer coal beds of moderate pitch or the harder beds if roof pressure is used to help free the coal and for beds 3 to 6 feet thick. Where conditions were favorable, the coal was broken so rapidly that the capacity of standard conveying equipment proved entirely inadequate, and the coordination of such face-work tasks as timbering and backfilling became extremely difficult.

One example of coal-planer performance was the monthly production of 22,500 tons from a 200-meter (660-ft.) face in a 1.7-meter (5-ft., 7-in.) bed pitching 2 degrees; in eight consecutive months, this same operation produced 168,300 tons.[4] In June 1943 it was estimated that by October 1944 some 200 coal planers of standard design would be in use in the Ruhr.[5] In January 1945 it was stated there were 12 trouble-free operations.[4]

INTRODUCTION

The Ruhr coal basin is estimated to cover an area of more than 1,000 square miles. Here, the total thickness of the coal-bearing formation (Carboniferous) is 10,500 feet, and drill-hole records have revealed 92 coal beds with a total thickness of 262 feet.[6] Beds pitch from 0 to 90 degrees, and about 70 percent of the wartime production came from beds that pitched less than 30 degrees.[5]

For example, at the Minister Stein mine there are 24 minable coal beds ranging from 80 centimeters (2 ft., 7½ in.) to 250 centimeters (8 ft., 2½ in.). The vertical thickness of the measures is 1,000 meters (3,200 ft.), and at this mine the deposits are covered with 150 meters (500 ft.) of surface wash. The cross section (fig. 1) at Fritz mine, Hoesch, A. G., Essen, Ruhr, is characteristic.

4/ Bergbau-Vereins, Essen.

5/ Lange, Fritz, Die Arbeiten des Ruhrbergbaus zur Einführung und weiteren Entwicklung der schälenden Gewinnungsmaschinen. Published in Arbeitssitzung der Hauptausschüsse für Forschungswesen des Bergbau-Vereins in Essen, am 25, Juni 1943, p. 17. (Restricted circulation within the Ruhr coal industry.)

6/ Rice, George S., and Hartmann, Irving, Coal Mining in Europe: Bureau of Mines Bull. 414, 1939, pp. 18-19.

The mines have been developed and worked to vertical depths of 2,000 to 2,500 feet by vertical shafts; main-level intervals are 500 to 700 feet apart. Haulage roads are straight, driven in rock, and centered as nearly as practical between property bourdaries. Levels are sectionalized by driving crosscuts at right angles to the main haulage road on 800- to 900-foot centers. These roads are the main transportation arteries for the use of trolley or Diesel locomotives. A plan of the sixth main level (fig. 2) at the Bruchstrasse mine, Gelsenkirchener A. G., Bochum, illustrates main-level development and sectionalizing with crosscuts. The cross section in figure 3 is that of the fourth crosscut west at the same mine.

On the average-size mining property, a main level has a life of about 20 years, and 5 years are required to develop fully a new working level. Operations are so systematized that the upper level is finishing, the main level is in full production, and the next lower level is undergoing development.

In the 1937-38 coal year (April 1 to March 31), the Ruhr district accounted for about 143 million net tons (69 percent) of Germany's 207 million tons of bituminous coal production;[7/][8/] in the 1940-41 coal year, Ruhr coal production was about the same as in 1937-38, but the German total had increased to some 273 million tons. In 1943-44, the Ruhr's production of 138 million tons was but 47 percent of the Reich total of 295 million. The increase in total bituminous coal production in the war years came mainly from Upper Silesia, where production more than trebled.

In the 1940-41 coal year, about 30 thousand (4.7 percent) of the 635 thousand mine workers were foreign civilians, military internees, or prisoners of war. In 1943-44, employment approximated 785 thousand, of which more than 35 percent were foreign workers.

In the 1938 calendar year, the output per man per shift for underground workers in bituminous-coal mines of the Ruhr district was 2.167 tons. In 1940 this figure increased to 2.214 tons, but in 1944 it decreased to about 1.8 tons. The output per man per shift for underground workers in all of Germany's bituminous mines in 1943 and 1944 approximated 2 tons.

In the Ruhr district, about 50 percent of all underground workers are engaged in the actual mining of coal. The distribution of underground workers for the Bruchstrasse mine (table 1) is typical, although a number of mines have several times its total number of employees.

The Ruhr district was hard-pressed to maintain its output of high-grade coals because of the shortage of skilled miners. The objectives in development of new mining equipment and methods were (1) increasing the effectiveness of the skilled miner, (2) maximum output from available working places through the elimination of deadwork shifts, and (3) increasing production efficiency

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[7/] All production figures in this report are in net tons of 2,000 pounds.

[8/] Data relating to production and employment are from the official translation of Reichsvereinigung Kohle Statistischer Bericht, Nr. 11, Berlin, May 1944.

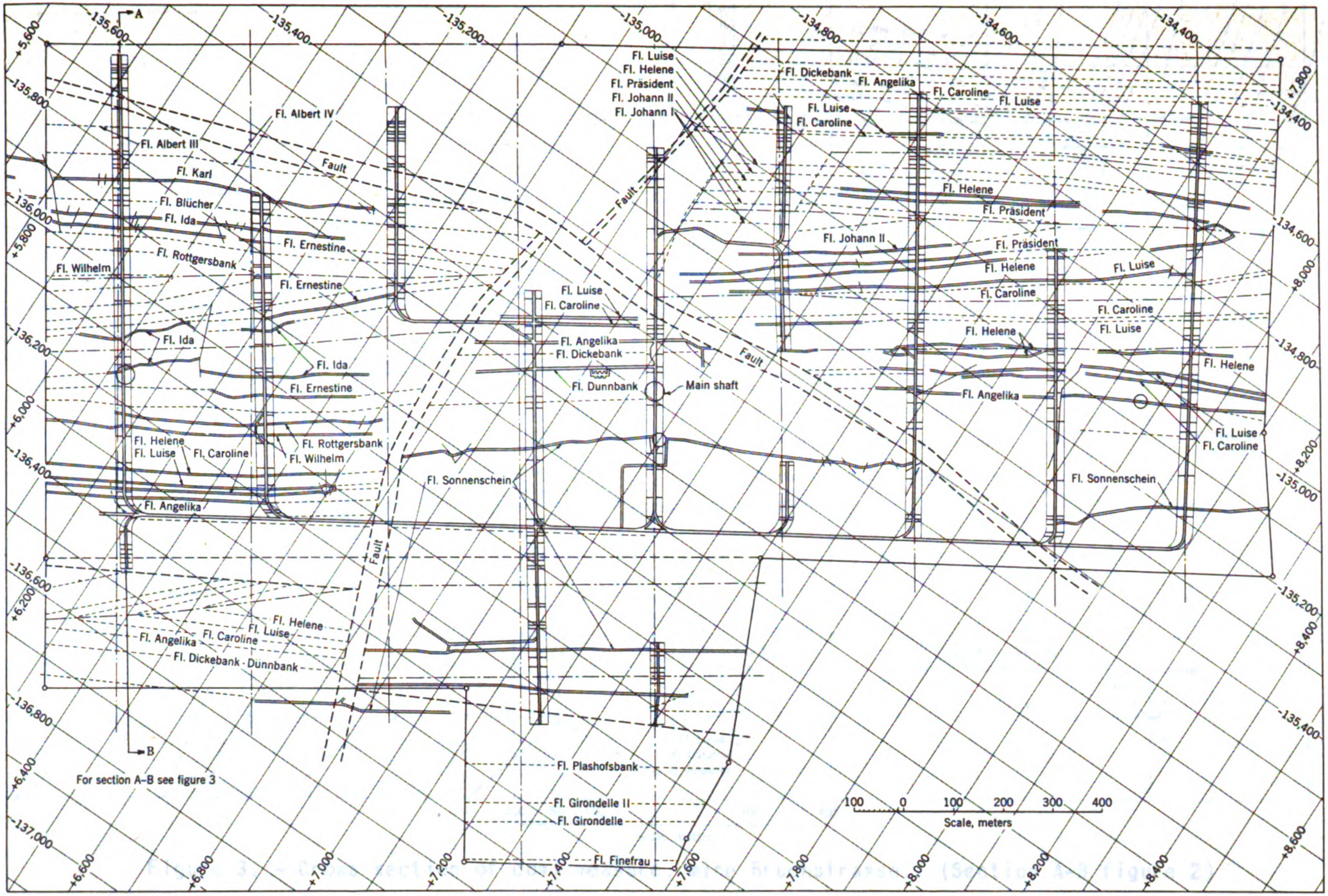

Figure 2. - Plan of 6th level, mine Bruchstrasse.

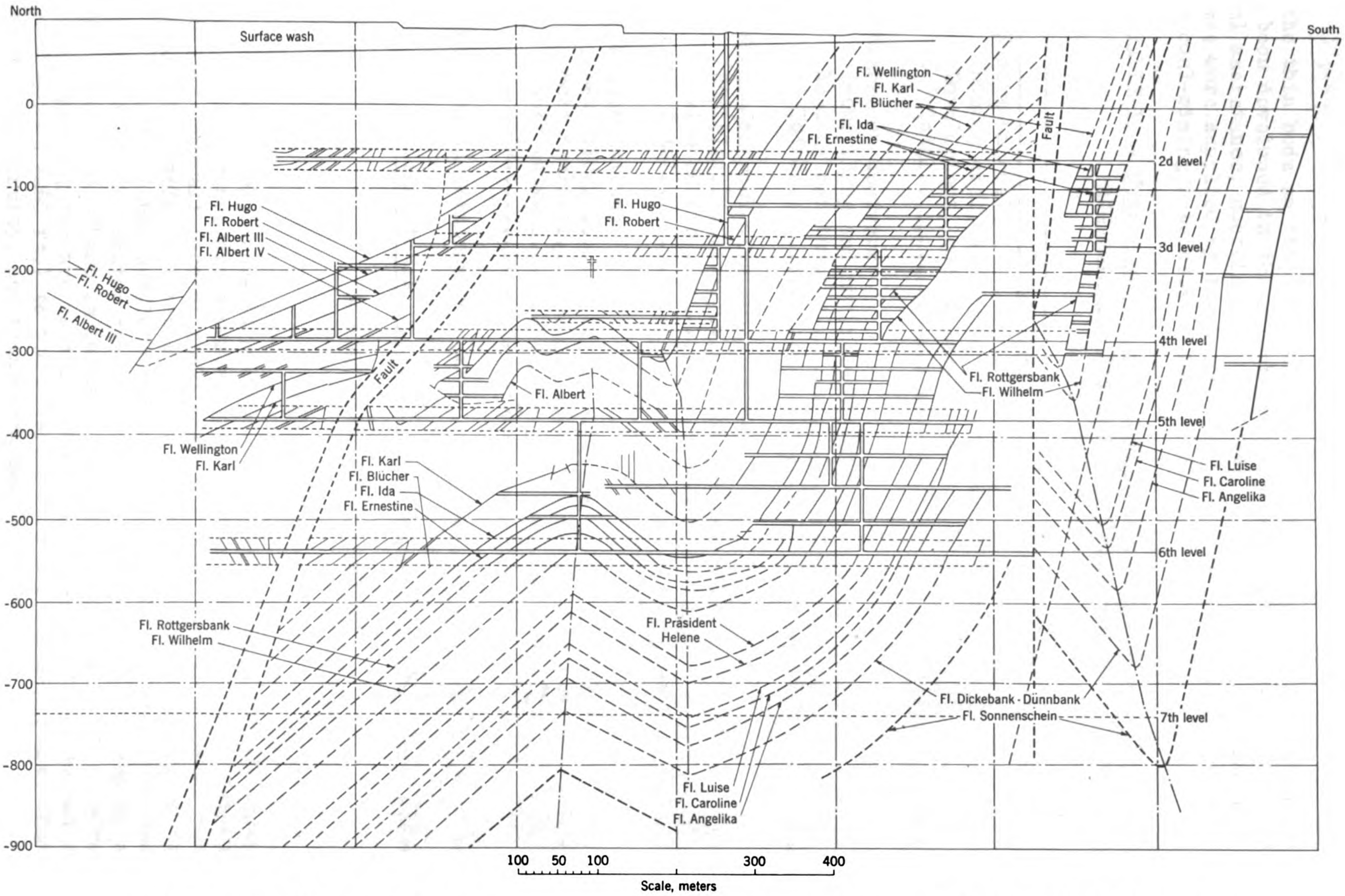

Figure 3. - Cross section of coal measure, mine Bruchstrasse. (Section A-B figure 2)

in the thin beds so that coal not considered economically minable, but which had been developed in the normal course of operations, could be mined. Technical assistance, coordination of effort, and incentives in the form of cash prizes were supplied by the technical service and research association of Ruhr coal-mining interests (Bergbau-Vereins).

TABLE 1. - Number of men employed underground and percent of total, by occupations, Bruchstrasse mine, Gelsenkirchener Bergwerks, A. G., Bochum, Ruhr

Occupations	Number of men	Percent
Miners on coal:		
Mining coal, timbering, and loading coal.	300	21.4
Development, coal gangways, and chutes...	350	25.0
Total..	650	46.4
Miners on deadwork:		
Backfilling and moving equipment........	250	17.8
Roadway maintenance........................	135	09.7
Total..	385	27.5
Miners on rock-development work:		
Tunnels..	100	07.2
Inside shafts..................................	90	06.4
Total..	190	13.6
Transportation:		
Gathering......................................	135	09.7
Main haulage..................................	10	00.7
Shaft bottom..................................	10	00.7
Total..	155	11.1
Mechanical maintenance, total............	20	01.4
Grand total..................................	1400	100.0

CONVENTIONAL MINING METHODS

Flat Mining

In flat-pitch, longwall mining (beds pitching less than 30 degrees), top and bottom roads are advanced singly along the strike and connected with a straight longwall face at right angles to them; or, in moderate pitches, three single development roads may be driven, dividing the area to be mined into two nearly equal sections for longwalling. If two roads are used, coal is delivered to the bottom road, the upper road serving as a supply road; if the three-road scheme is followed, coal is delivered to the center road and the remaining two are used for supplies. Longwall face lengths range from 80 meters (260 ft.) to 250 meters (820 ft.), depending upon changes in pitch, bed continuity, and transportation facilities.

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The pneumatic pickhammer is the tool of every miner for winning coal. In friable coals the use of the pickhammer without blasting presents little difficulty; in harder coals the face is subjected to controlled roof pressure as an aid to winning without blasting. Lightweight chain-shearing machines (12 to 20 horsepower) are used to some extent with limited blasting, but where they are used the pickhammer is the principal tool for the final winning.

Loading is by hand onto shaker, chain, or belt face-conveyors, which in turn discharge onto mother-belt conveyors for delivery of coal into mine cars of 1 to 4 tons capacity at central loading points. Where the pitch warrants, some use is made of the chain and disk-type retarding conveyor, if the face is straight and loading is by hand.

Mined-out areas may be caved, completely backfilled either by hand or by pneumatic-packing machines, or strip-packed by hand or machine. Strip packs 20 to 25 feet wide, built at right angles to the longwall face, are continuous, and the intervening, unsupported roof of 15 to 20 feet between packs is caved. Broken roof rock is removed from the caves and used to build the packs. Roof pressure can be controlled to some extent by varying the width of packs and the distance between them.

The principal form of roof support is the collapsible, yielding type of steel prop with steel caps (cross beams). The Schwartz prop (fig. 4) is widely used. Caps are beam-section or flat, channel-section types. Square-cut wood cogs (chocks) with steel cog releases are often used with a full caving system or at cave openings with strip packing.

Steep-pitch Mining

Contemporaneous backfilling is standard practice in longwalling beds that pitch more than 30 to 35 degrees. Single top and bottom roads are advanced along the strike at a vertical interval of 100 feet for a 50-degree pitch to 150 feet for a 70-degree pitch. The application of this practice is somewhat limited by abrupt changes in pitch. The stepped-face method (fig. 5) is in general use. This method provides a maximum number of working places in which each miner works independently without endangering the miner working below him. Fill, transported to the dumping point in mine cars, is run from the top roads.

Blasting is eliminated by using pneumatic pickhammers to break the coal, which is under pressure. The dislodged coal falls from the face and is run by gravity to the car-loading pockets, either on steel chutes placed on the fill against the footwall or on the open fill. The cross-pitch angle is 32 degrees if steel chutes are used and 45 degrees if coal is run on the open fill.

The exposed roof areas along the working faces are supported by wood props and caps; wood sills are used where needed. Props are wedge-pointed at the bottom to permit yielding without splitting and to provide for good purchase. Each cap or sill is long enough to accommodate at least three props. All timbering is according to predetermined standards and is carried out meticulously. Face timber is not removed.

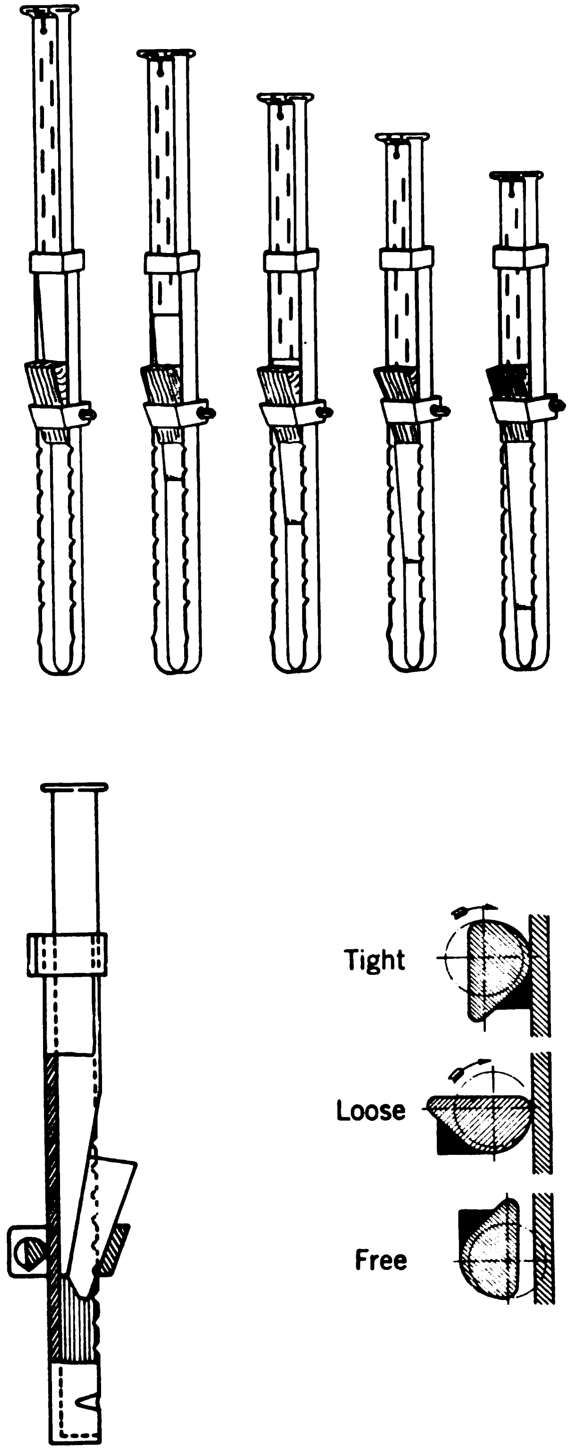


Figure 4. - Schwartz mine prop.

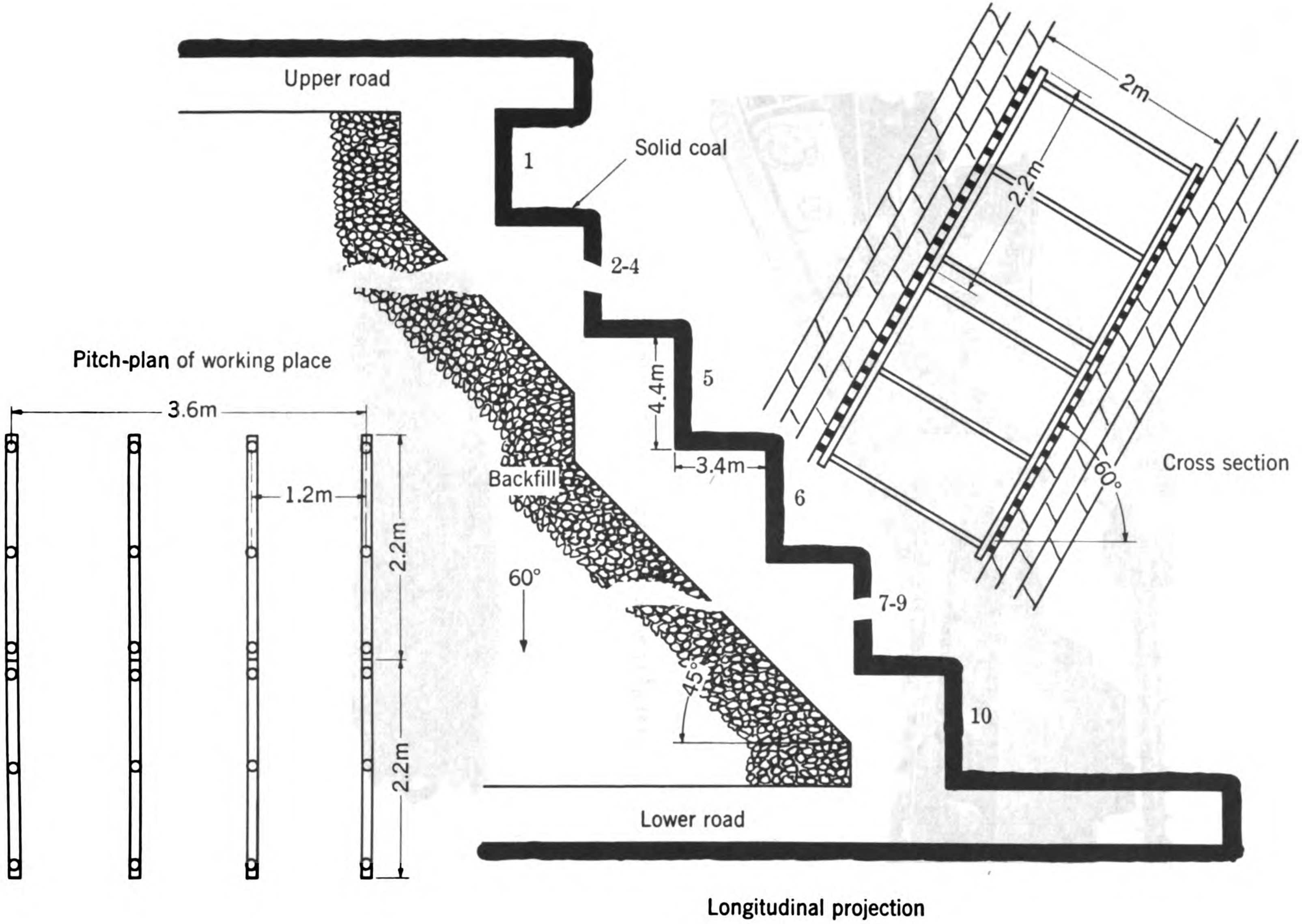


Figure 5. - Hand-mining layout, steep pitch, mine Bruchstrasse.

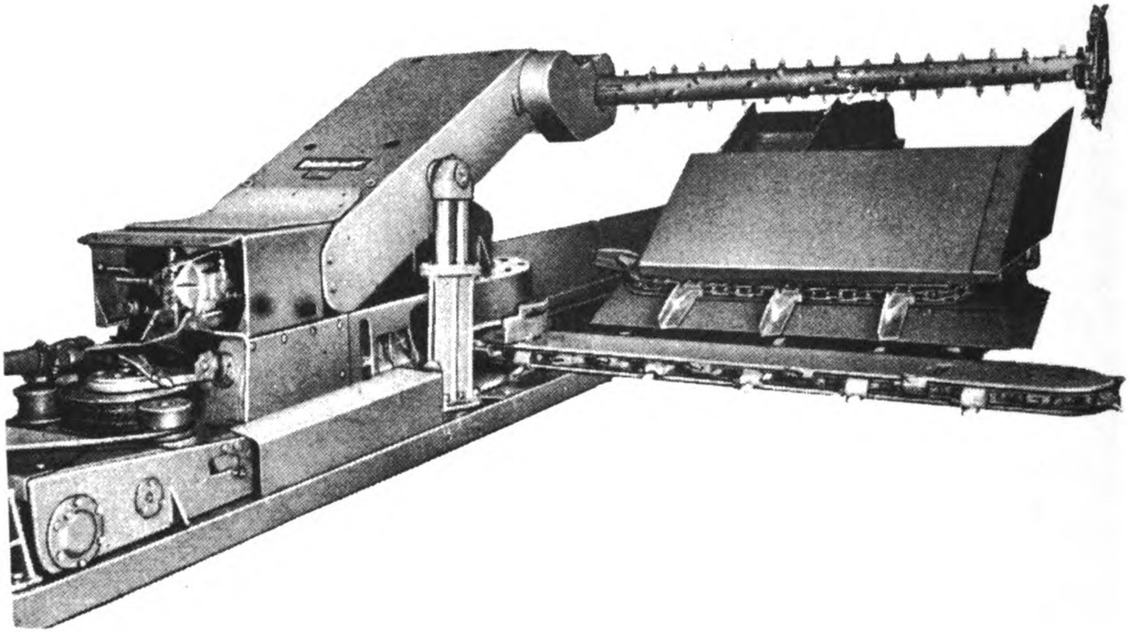


Figure 6. - Eickhoff Schrämlader.

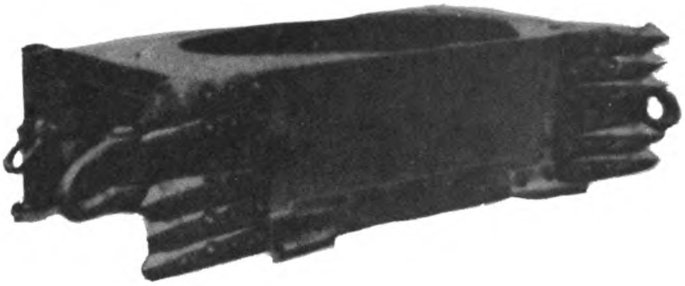
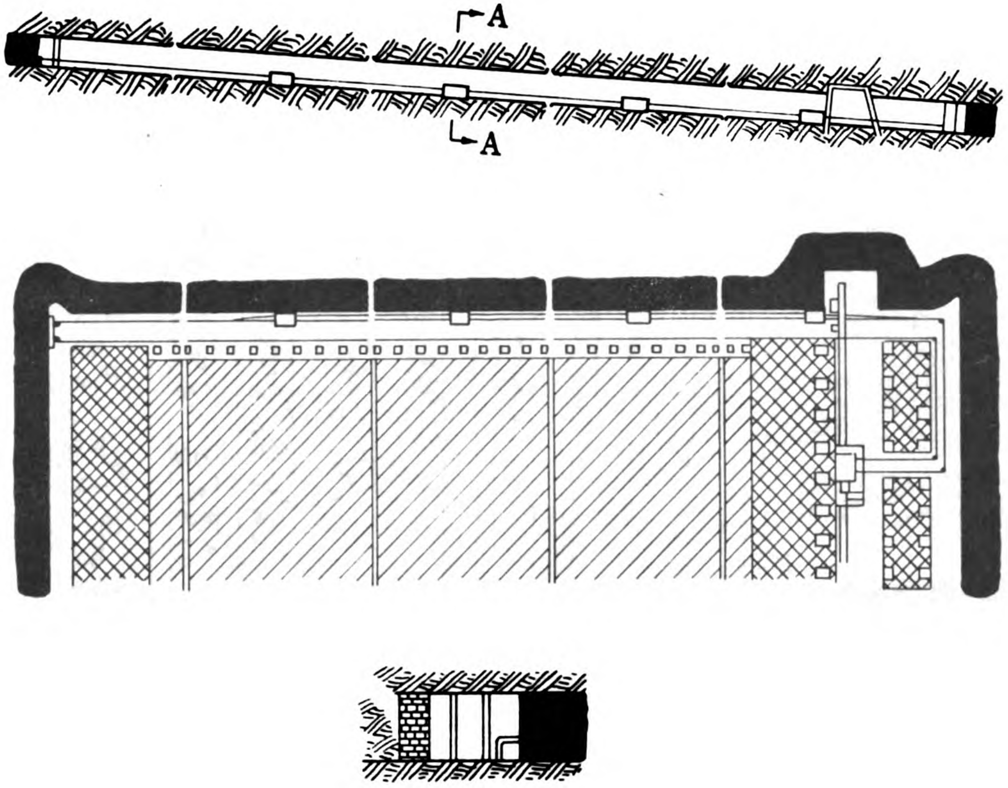


Figure 7. - Harmann scraper.



Section A-A

Figure 8. - Longwall layout for Harmann scraper.

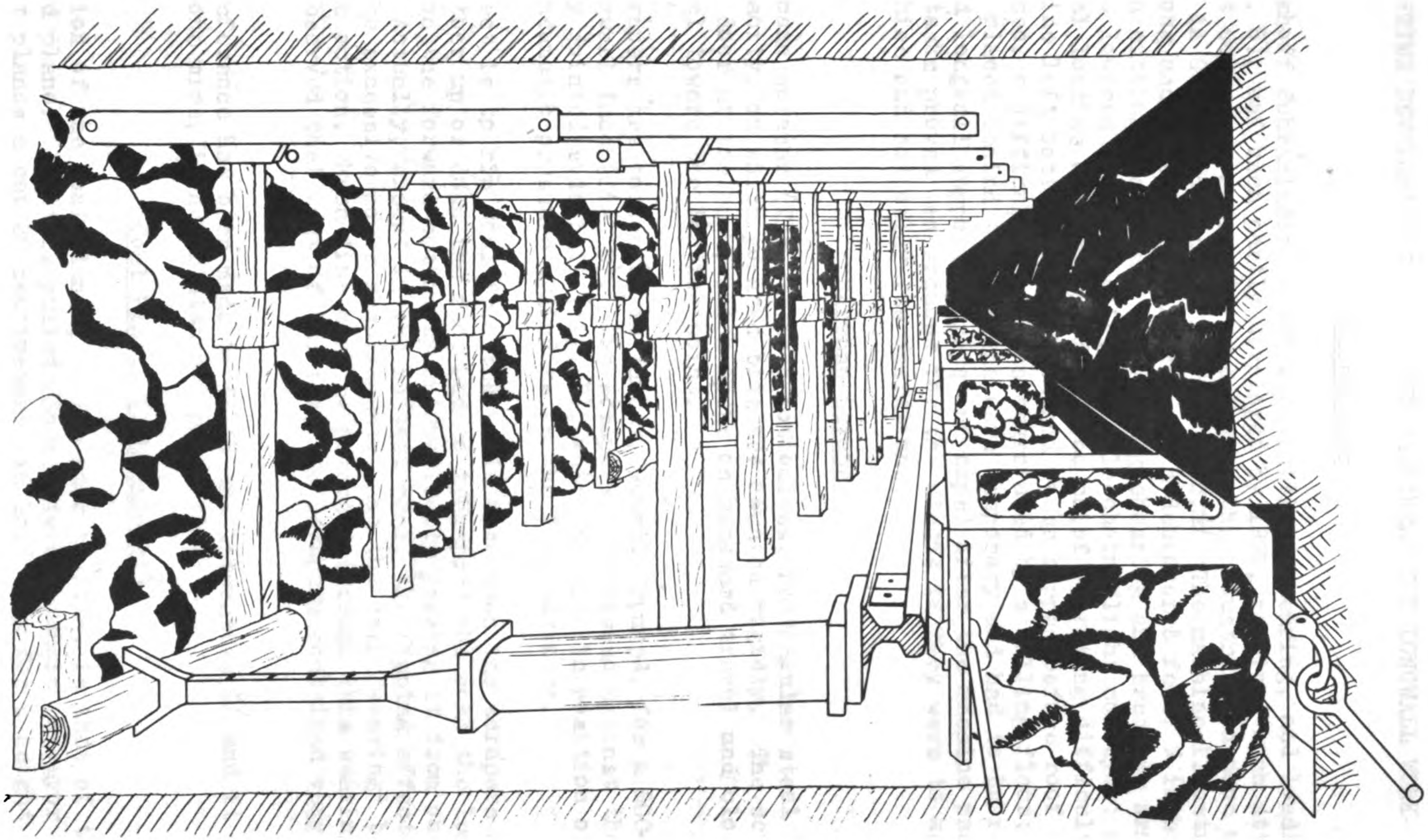


Figure 9. - Face details, Harmann scraper.

WARTIME DEVELOPMENTS IN MINING MACHINERY FOR LONGWALL WORK

Schrämlader

The Eickhoff Schrämlader, a combined cutting, shearing, and loading machine (fig. 6), had been partly developed by 1939, received much attention in 1942[9] but was never generally accepted by the industry, and none were in operation in German coal mines in July 1945.[4] The machine illustrated is 28 feet long and 4 feet high and cuts to a depth of 5 feet, 9 inches. It consists of a cutting mechanism; a revolving shearing and breaking arm, which is raised and lowered hydraulically; a single-chain flight conveyor; and two additional loading conveyors. The three chief operating difficulties were (1) the machine left bottom coal, which had to be ripped before roof supports could be placed, a difficulty that was aggravated by a rolling floor; (2) single props placed behind the machine were temporary and had to be replaced with standard longwall supports (props and caps) after the machine passed by; and (3) the tasks proved too arduous for the miners if they were to keep up with the machine and not delay its operation.

Harmann Scraper

The Harmann scraper (fig. 7) is a bottomless, rectangular steel box of 1-ton capacity, on which pointed bits are mounted rigidly. The scraper has a hinged door at the back, which opens on backward travel and closes on forward travel toward the loading point.

Four scrapers are connected in tandem, equally spaced, for a 600- to 700-foot longwall face (fig. 8). The scrapers are pressed against the coal by a flexibly jointed side rail (fig. 9), which is held in position or moved forward by pneumatic pressure cylinders as the face advances.

The object is to rip coal from the solid face when the scrapers are traveling either up or down the face and to transport the coal the length of the wall on the forward motion by automatically passing it from one scraper to another. Actually, except in the softest coal, the ripping effect is lost because of the excessive power requirements, and the term "wearing" better describes the action. Much fine coal is produced through this wearing action, and it was observed that most of the time the scrapers contained very little coal.

While reference has been made to it in the literature,[5] and it is used in at least one mine, it never attained popularity.

Coal Planer (Kohlenhobel)

The action of the coal planer, as its name implies, is that of the ordinary wood plane. As it is pulled along between a chain conveyor and the coal face, it planes a cut 30 centimeters (12 in.) deep for a height that equals one-third to two-thirds of the bed thickness and, in passing, loads the coal so planed as well as any loose coal that lies in its path. The upper part of the seam either caves or is barred down and is loaded on the return trip.

---

[9] Eickhoff Mitteilungen, August-September 1942, describes an award of 50,000 marks by the Bergbau-Vereins, Essen, for developing the Schrämlader.

All of the information relating to design, operation, and performance of the coal planer, with the exception of that which refers to the Monopol mine,[10] was obtained through interviews with German engineering and operating personnel and visits to working faces. All data so obtained were not included in this report, as certain of these are outmoded and others are deemed to be incomplete or unreliable.[11]

Standard Design

The coal planer consists essentially of a fabricated steel box frame (blade holder) with a ramp for discharging coal into the face conveyor, a steel blade or planer bit, a forward scoop that cleans loose coal from the path of the planer and loads it into the conveyor, and a forward arm, which carries a sheave over which the pull rope is passed. One end of the rope is anchored at the extreme end of the longwall face; the other end is wound on a hoist drum, by means of which the planer is pulled along the face.

The forward scoop and forward arm are pin-connected to the blade holder for up-and-down motion. The over-all length of one blade holder and forward arm is 10 to 12 feet. The height of the blade, which is the maximum vertical dimension of the planer, is one-third to two-thirds the bed thickness. A 30-centimeter (12-in.) cut, provided for by the blade offset, has proved the most satisfactory; cuts 10 centimeters (4 in.) to 80 centimeters ($31\frac{1}{2}$ in.) have been tried. Two symmetrical, opposite-hand sections are fastened together with pin, spring, and ball-joint connections in order to plane in opposite directions.

The underside of the Hannover-Hannibal coal-planer model (figs. 10a, 10b, 10c, and 10d) is grooved so that loose, fine coal will be scraped against the coal face as the planer passes. The blade material is hot-rolled machine steel (German designation ST 70/11, similar to United States SAE 1060).

The coal planer in use at the Monopol mine (figs. 11a and 11b) is nearly similar in design to the Hannover-Hannibal model, except that the sections of the blade are mounted to produce a sawtooth effect.

The sketch of the coal planer used at Ibbenbüren mine (fig. 12) shows the welded-steel construction and the manner of fastening the parts of the coal planer together. The 43-degree blade angle is important because it governs the entering or digging action; the 55-degree blade angle is designed to provide foot-lead, which counteracts the tendency to climb. In a more recent

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[10] Courtesy J. Hunter, managing director, Doncaster Amalgamated Collieries, Ltd., Doncaster, England.

[11] Original documents filed Bag No. 1481, Ministry of Fuel and Power, London. Microfilm of documents filed with Bureau of Mines, Office of Synthetic Liquid Fuels, Washington, D. C.

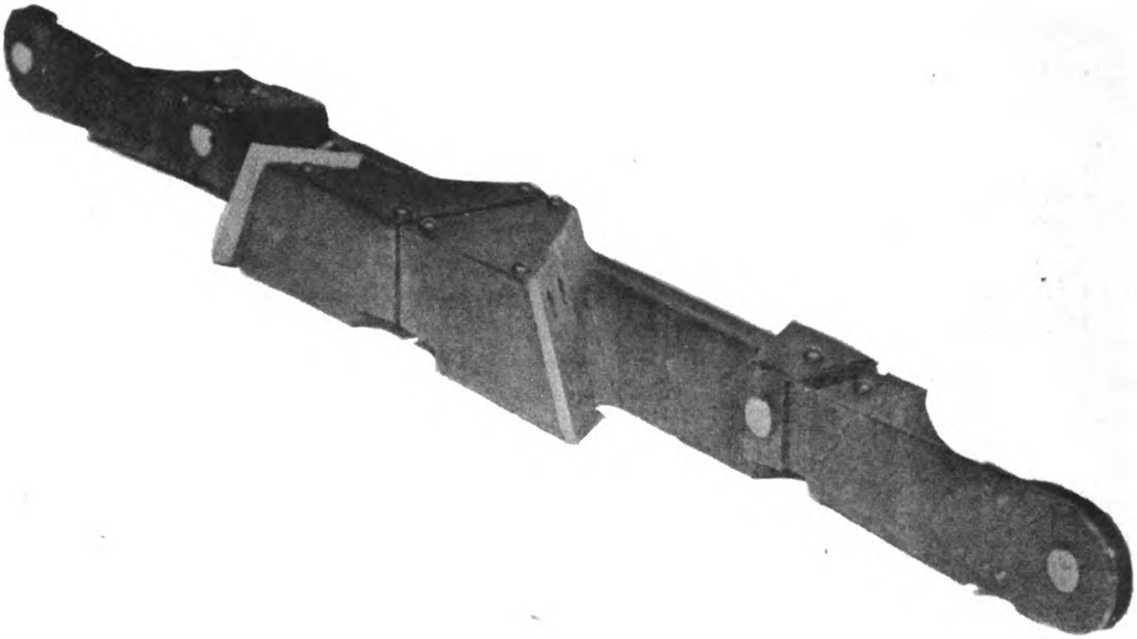


Figure 10a. - Hannover-Hannibal coal planer model, viewed from coal face.

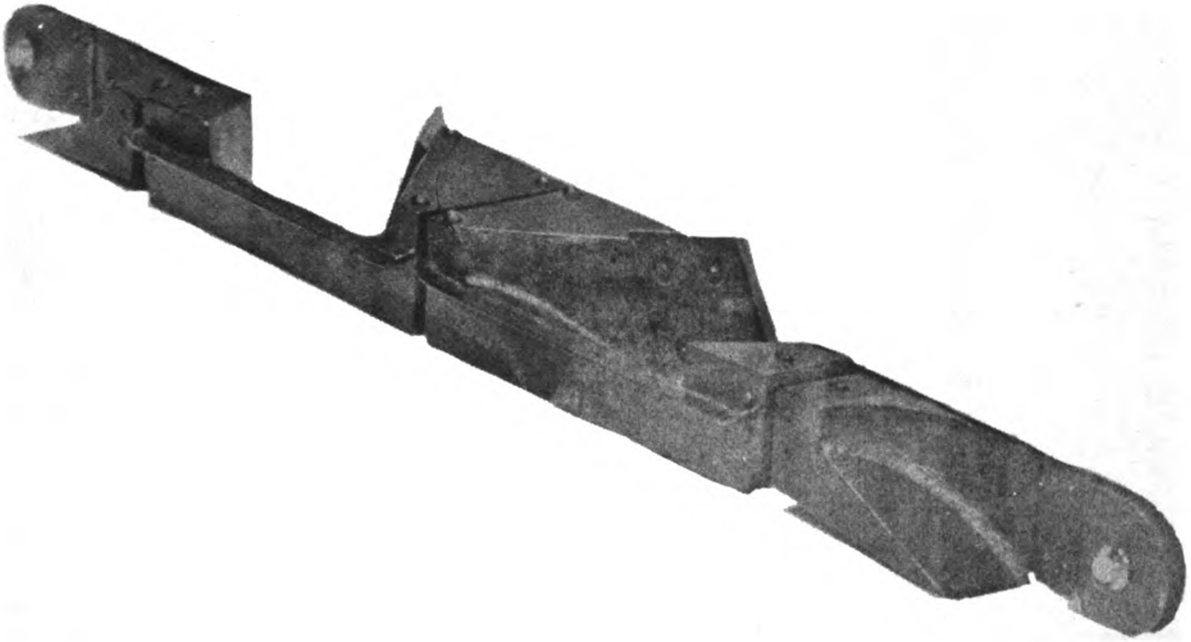
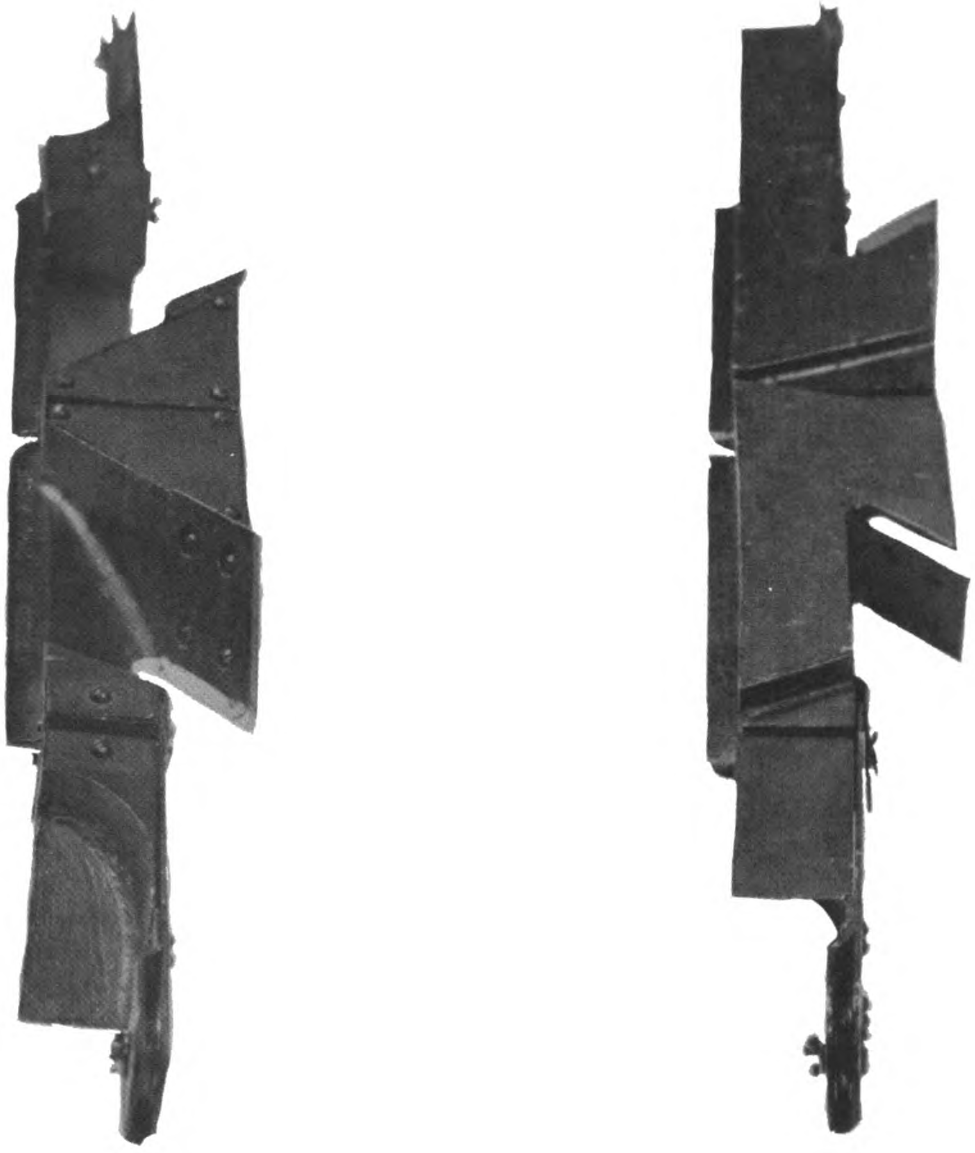


Figure 10b. - Hannover-Hannibal coal planer model, viewed from conveyer.



10c

10d

10. - Hannover-Hannibal coal-planer model: c, view from top in direction of travel; d, view from underside in direction of travel.

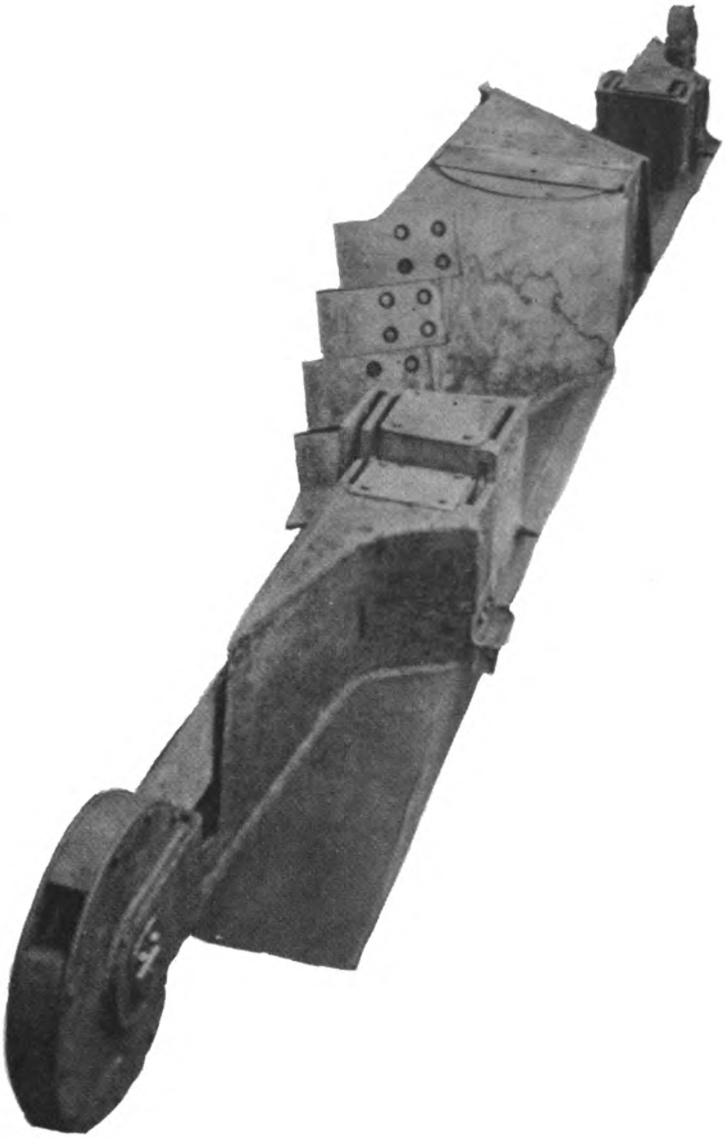


Figure IIa. - Monopol planer, viewed from top in direction of travel.

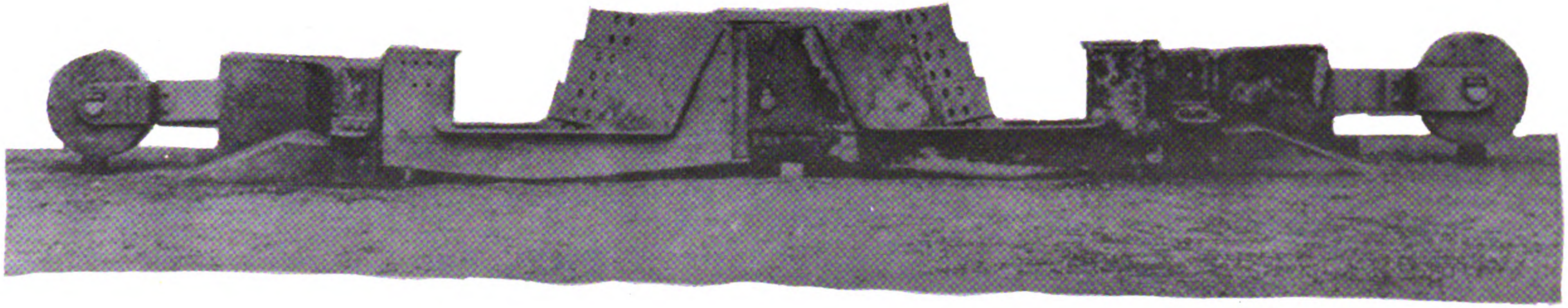
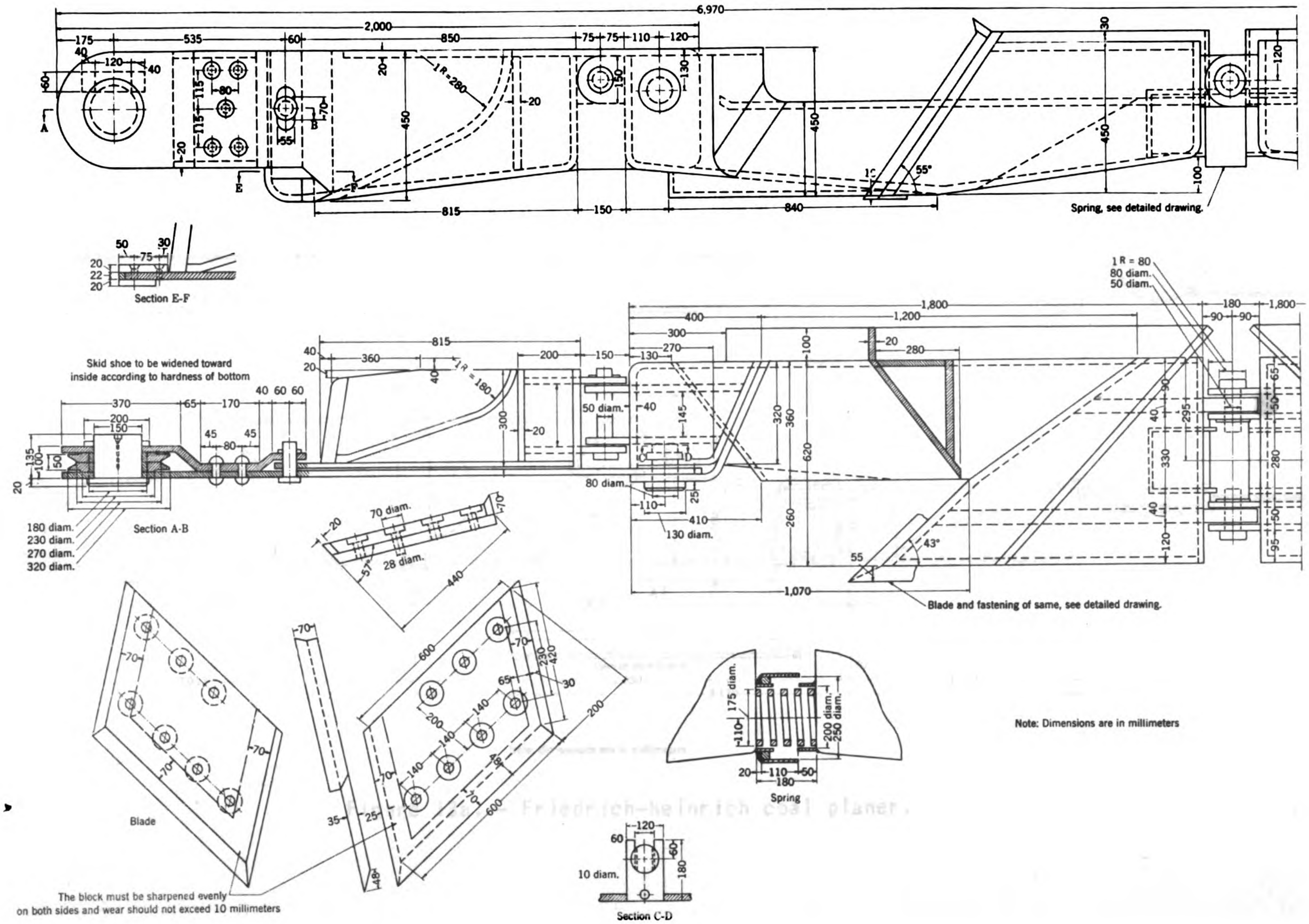


Figure 11b. - Monopol planer, side view.



Skid shoe to be widened toward inside according to hardness of bottom

Spring, see detailed drawing.

Blade and fastening of same, see detailed drawing.

Note: Dimensions are in millimeters

The block must be sharpened evenly on both sides and wear should not exceed 10 millimeters

Figure 12. - Ibbenbüren coal planer.

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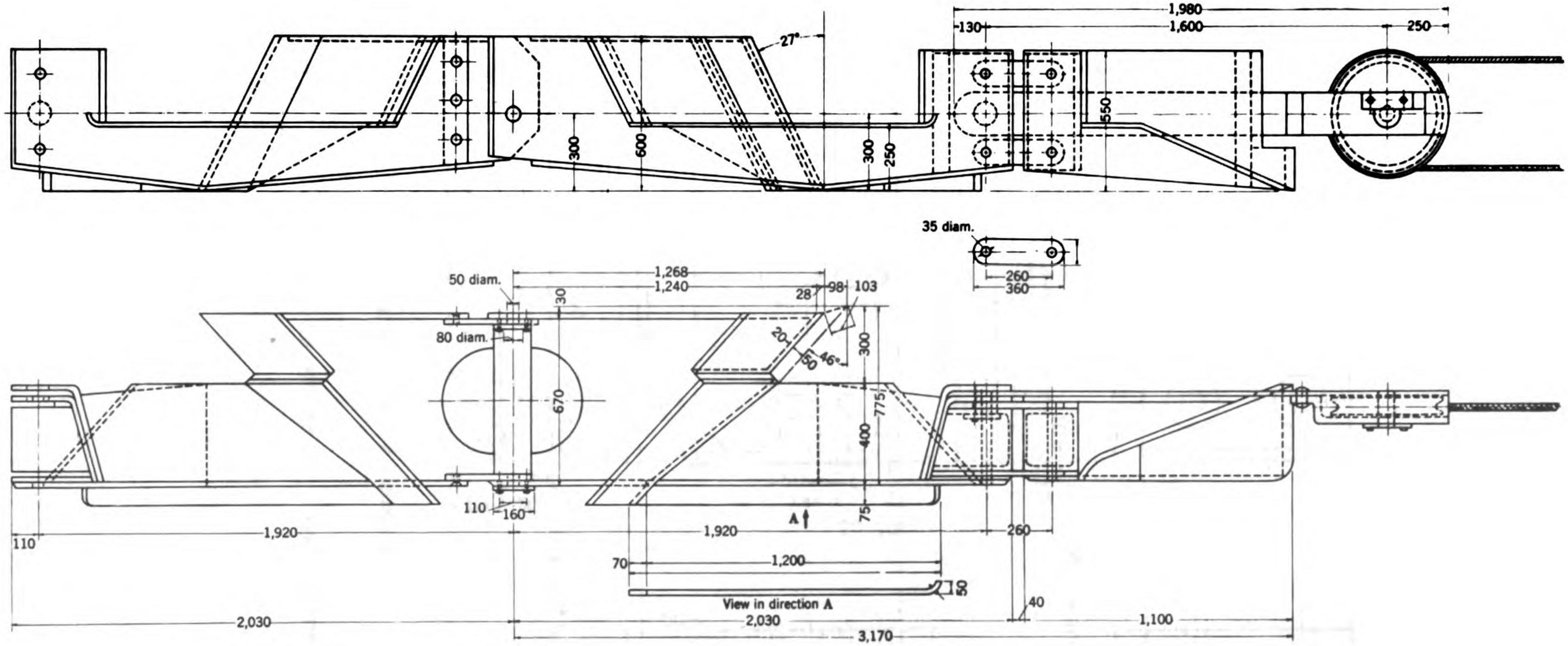

Note: Dimensions are in millimeters

Figure 13a. - Friedrich-Heinrich coal planer.

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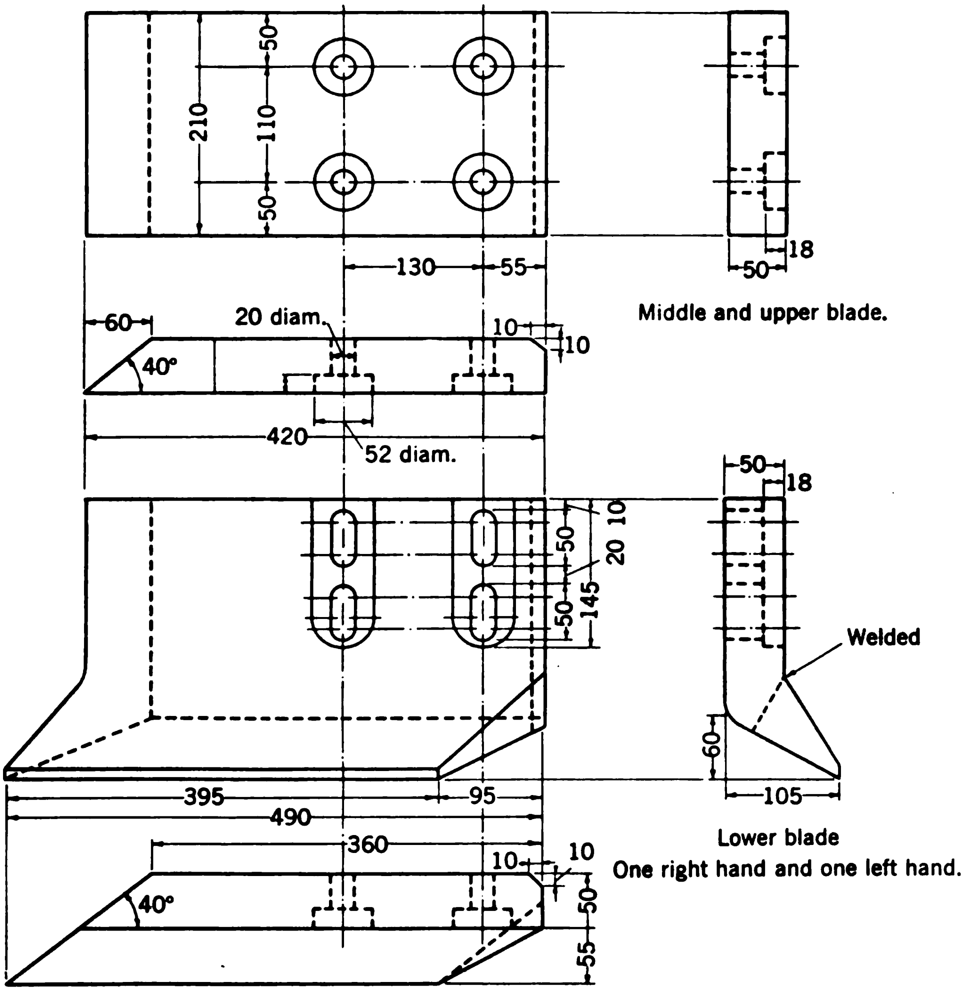


Note: Dimensions are in millimeters

Figure 13b. - Friedrich-Heinrich coal planer blade.

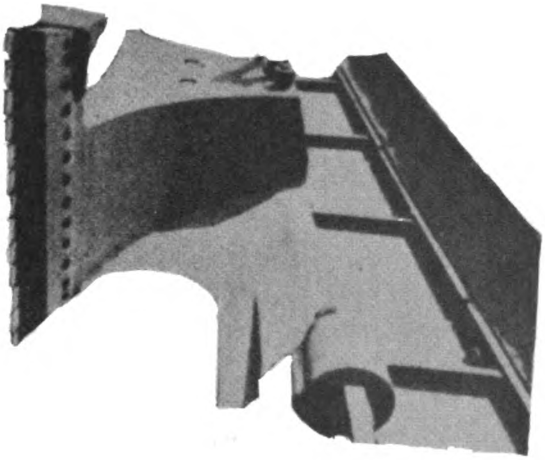


Figure 14. - Hannibal hewer.

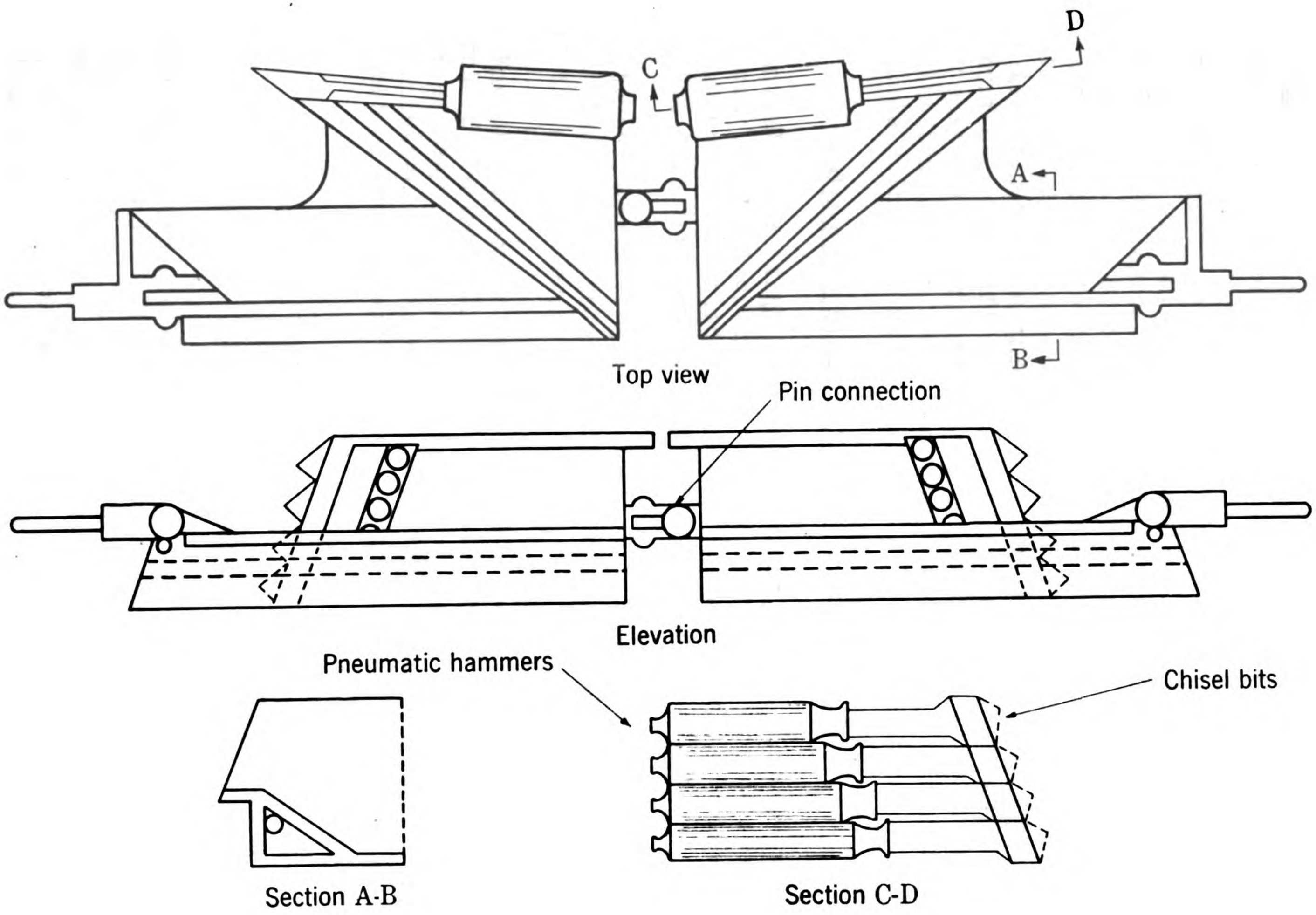


Figure 15. - Flottmann hewer.

design, the one-piece blade is replaced by one composed of separate sections for economy in maintenance; in the new design, the footpiece is turned outward in the direction of travel, as in the Hannover-Hannibal model. Present practice is to make the planer height two-fifths the bed height; the minimum height for a planer of this design is 0.45 meter (17-3/4 in.).

The most recent drawings were obtained at the Friedrich-Heinrich mine (figs. 13a and 13b) and are dated July and August 1945, respectively. The blade angles of 46 and 27 degrees approximate corresponding angles of the Ibbenbüren coal planer. The blade holder is recessed to receive the three sections of blade; the blade footpiece is turned outward as well as forward to aid in holding the planer to the mine floor. The wedge-shaped construction of the blade-holder floor plate throws the weight of the planer on the bottom blade-bearing surface. For soft mine floors, a design that distributes the planer weight evenly throughout its length has been found more favorable. The spring-type connection used in the Ibbenbüren coal planer for fastening opposite-hand blade holders is not used in this later design.

Designs for Planing Hard Bituminous Coal

In the Hannibal hewer (fig. 14), the straight, rigid blade of the coal planer is replaced by 13 chisel-type bits rigidly mounted onto the blade holder, which in turn is vibrated by an eccentric air motor. In the most recent design, the effective pounding force is said to be 400 tons.

In the Flottmann design (fig. 15), four chisel bits, each of which constitutes the blade of a separately mounted pneumatic hammer, replace the rigid blade of the coal planer.

Both the Hannibal hewer and Flottmann design were in the experimental stage at the end of the war. By July 1945, neither design had been proved, but the opinion of many of the engineers interviewed was that the Flottmann offered greater promise. It was not possible to view either of these planers in service because of bomb damage to mine surface plants where they had been used.

ACCESSORY EQUIPMENT

Coal-planer Hoists

If standard car hoists are used, two are required for each operation - one at each end of the wall. Various rope-pull requirements have been mentioned, but a 10-ton rope pull at the hoist drum, equivalent to a 20-ton effective pull on the forward pulley arm, if the planer speed is half the rope speed at the hoist drum, seems to be the average requirement. (Tests at Hannover-Hannibal mine indicated a 6-ton pull at the hoist drum.[5])

Because of the severe service aggravated by improper rope coiling, a capstan hoist with auxiliary winding drum was developed, in which all parts are mounted on a single frame.

The speed of coal-planer travel is 0.1 to 0.2 meter per second (4 to 8 in. per second, or 20 to 40 feet per minute).

Rope

Six-strand wire rope, 3/4 to 1-1/8 inch in diameter, is used. Seale construction is indicated, but no data are available relating to special ropes for planing coal, if they are used.

Main-sheave Mountings

Two types of main-sheave mountings are in use. The one in figure 16 consists of a movable block mounted on a simple I-beam frame; that shown in figure 17 is of the same general type, designed for ease in moving the conveyor it supports. In the second general type (fig. 18) the sheave is mounted on a steel box frame, which rests on the floor and against the coal rib in the stalls provided at both ends of the longwall face. The sheave wheel is 900-millimeter (36-in.) outside diameter, and the diameter of the bearing pin is 100 millimeters (4 in.).

Conveyors

Chain conveyors of the type shown in figures 19a and 19b are in general use with coal planers. The pan sections are 7 to 8 feet long and of heavy construction to withstand wear and stress in holding the coal planer against the face and to resist the heavy blows from falling coal. The pans are loosely connected to permit turning through a 5-degree angle.

Conveyor chain links are 18-millimeter (11/16-in. plus) diameter stock, but 20-millimeter (3/4-in. plus) stock is considered necessary. A special cross-bar link has been tried successfully, and with it each link retains its proper position in the linkage as well as being strengthened by it. However, the cost of production is said to be about 10 times the cost for making ordinary chain.

Heavy-duty conveyor design is said to be solved for capacities to 300 tons per hour. The conveyor used with the layout in figure 17 has an over-all width of 620 millimeters (24½ in.), a center-to-center chain dimension of 500 millimeters (19-3/4 in.), and an over-all height of 222 millimeters (8-3/4 in.); chain speed is 1 meter (39 in.) per second, or about 200 feet per minute. The conveyor is powered with two 30-kilowatt (40-hp.) electric drives for continuous operation, one at each end, and in addition by a 30-horsepower turbo-air drive at the discharge end for starting under heavy loads and for slow-speed operation in making routine checks of the conveyor chain. A Voith-Sinclair fluid (oil) transmission, installed between the electric motor and the gear train at the discharge end of the conveyor has solved the problem of effecting synchronization of the two electric drives; this, together with a 120-percent automatic overload time relay, has aided materially in reducing the number of breakdowns.

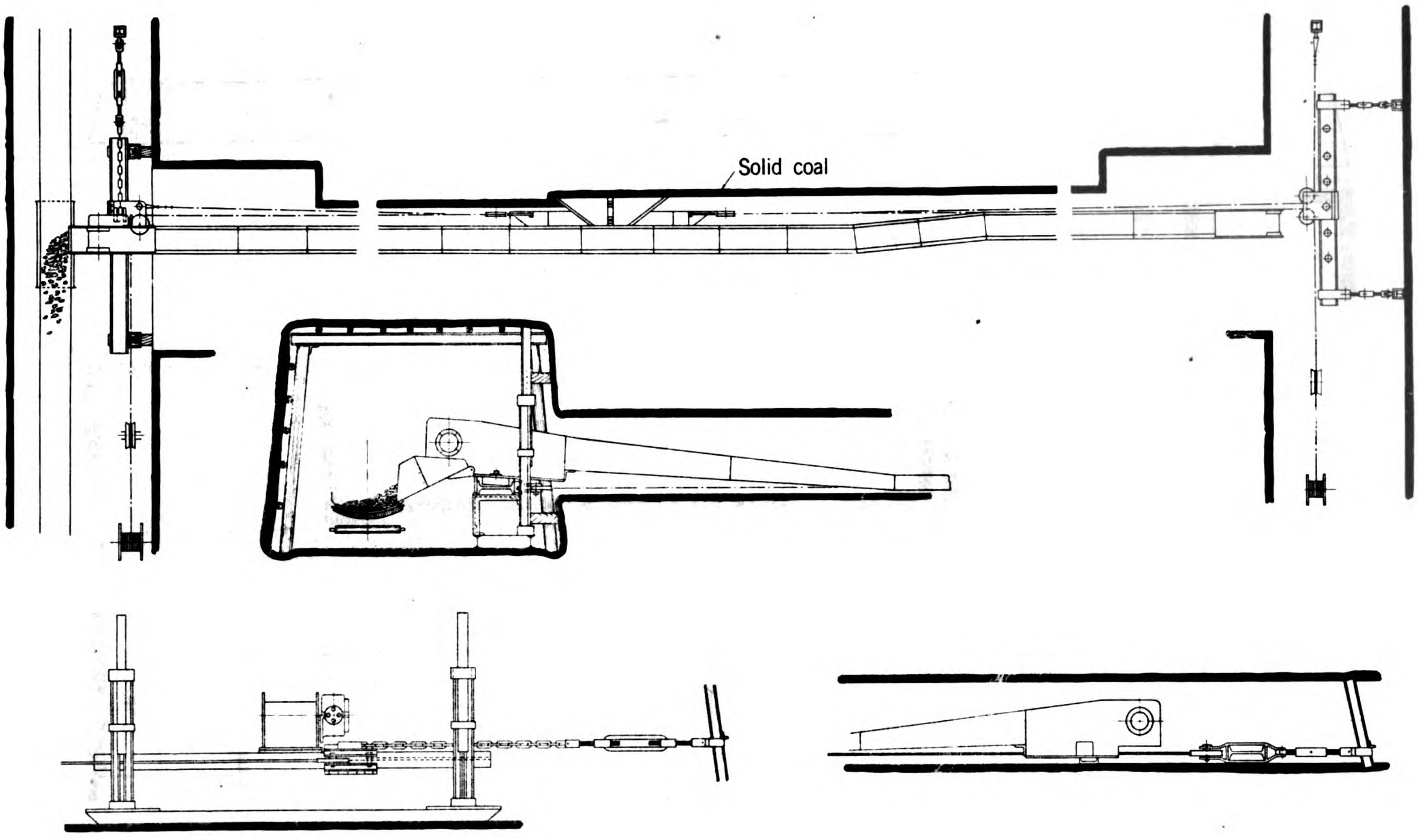
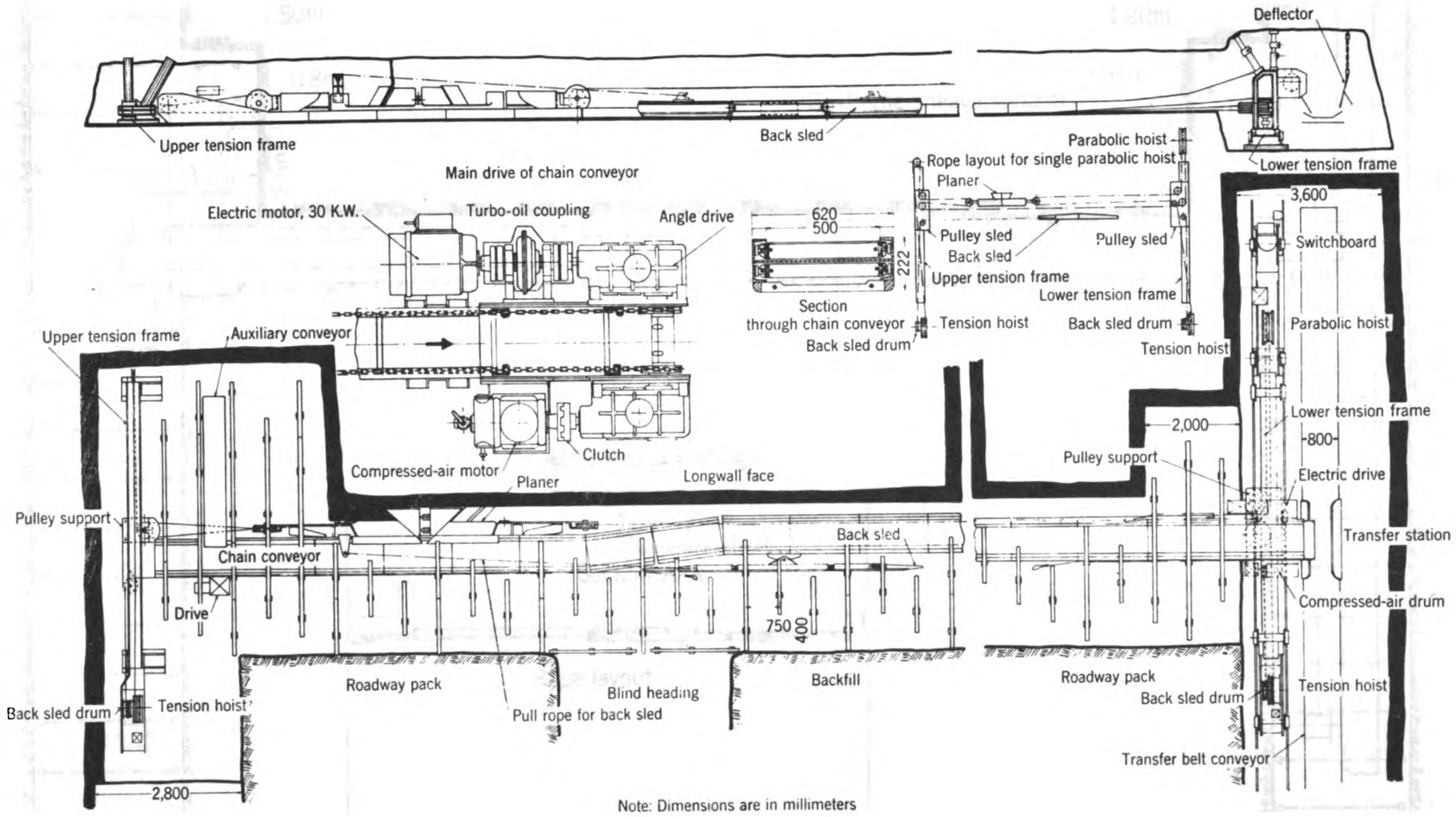


Figure 16. - Face layout, Monopol mine.



Note: Dimensions are in millimeters

Figure 17. - Face layout, Friedrich-Heinrich mine.

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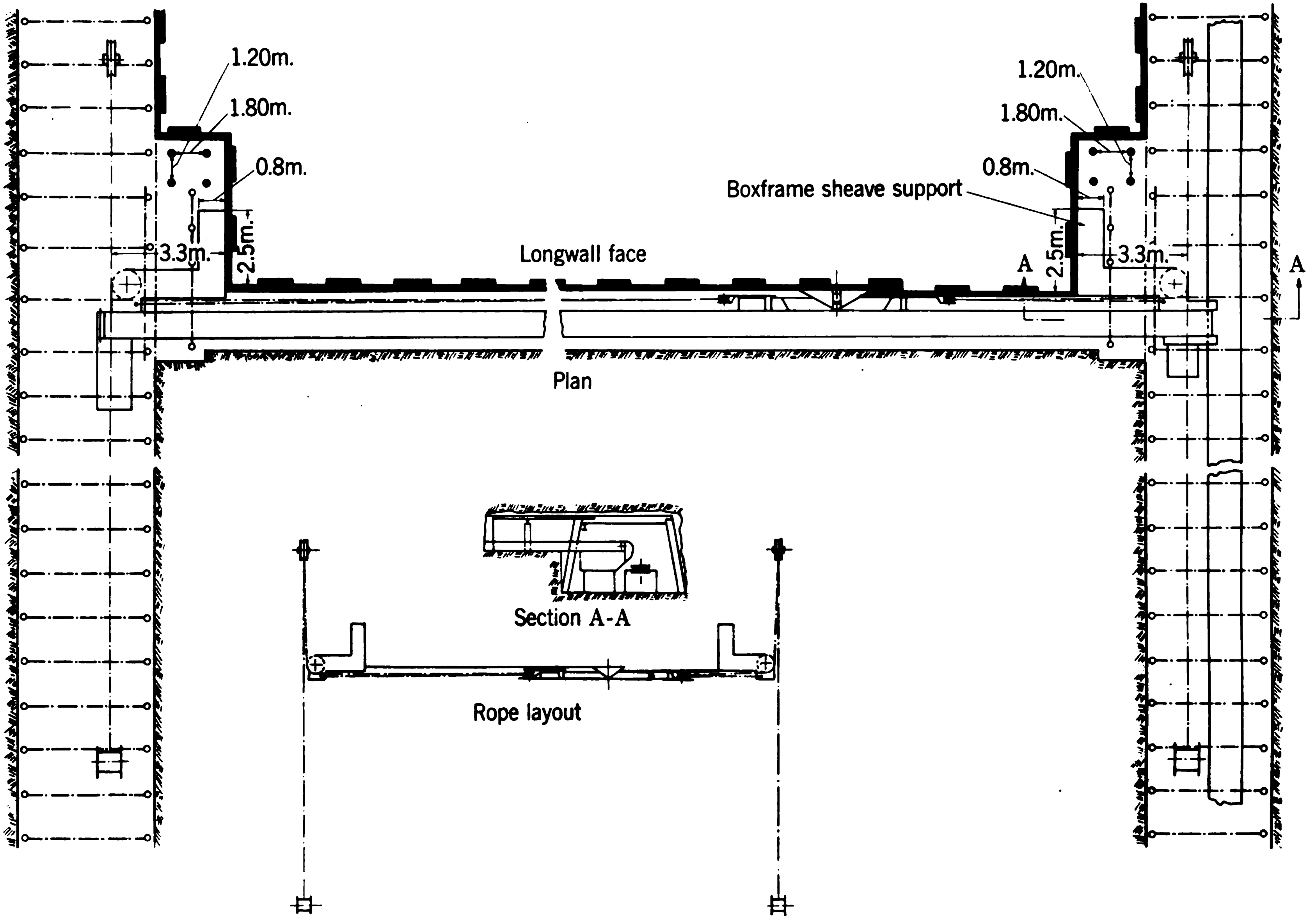


Figure 18. - Face layout, Ibbenbüren mine.

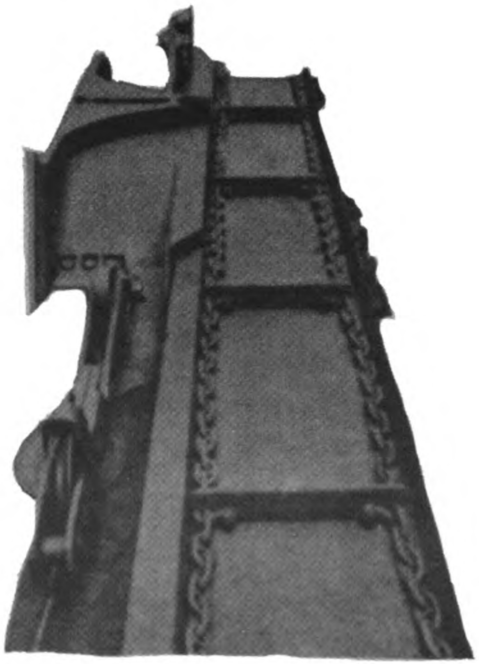


Figure 19a. - Coal planer and chain conveyer.

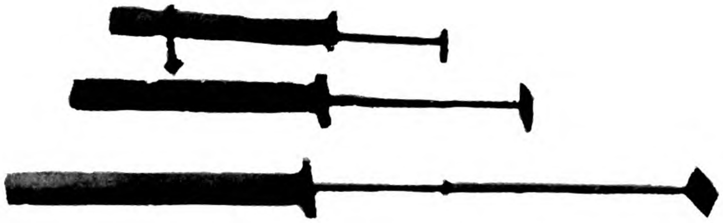
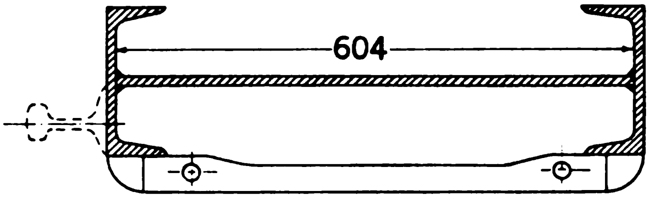
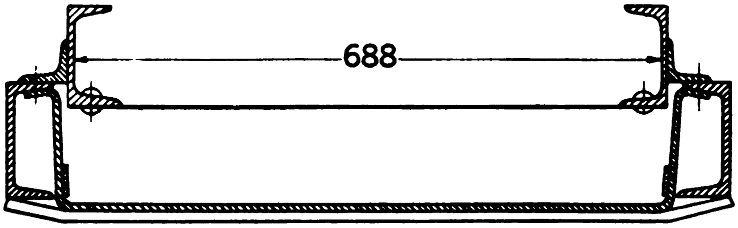


Figure 20. - Pneumatic rams for moving conveyer.

Westfalia Lunen



Demag Duisburg



Beien Herne

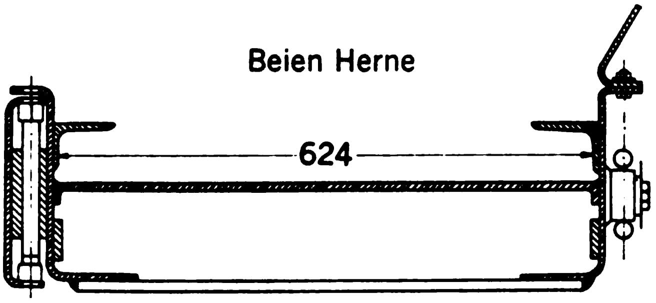


Figure 19b. - Cross sections, chain conveyers.

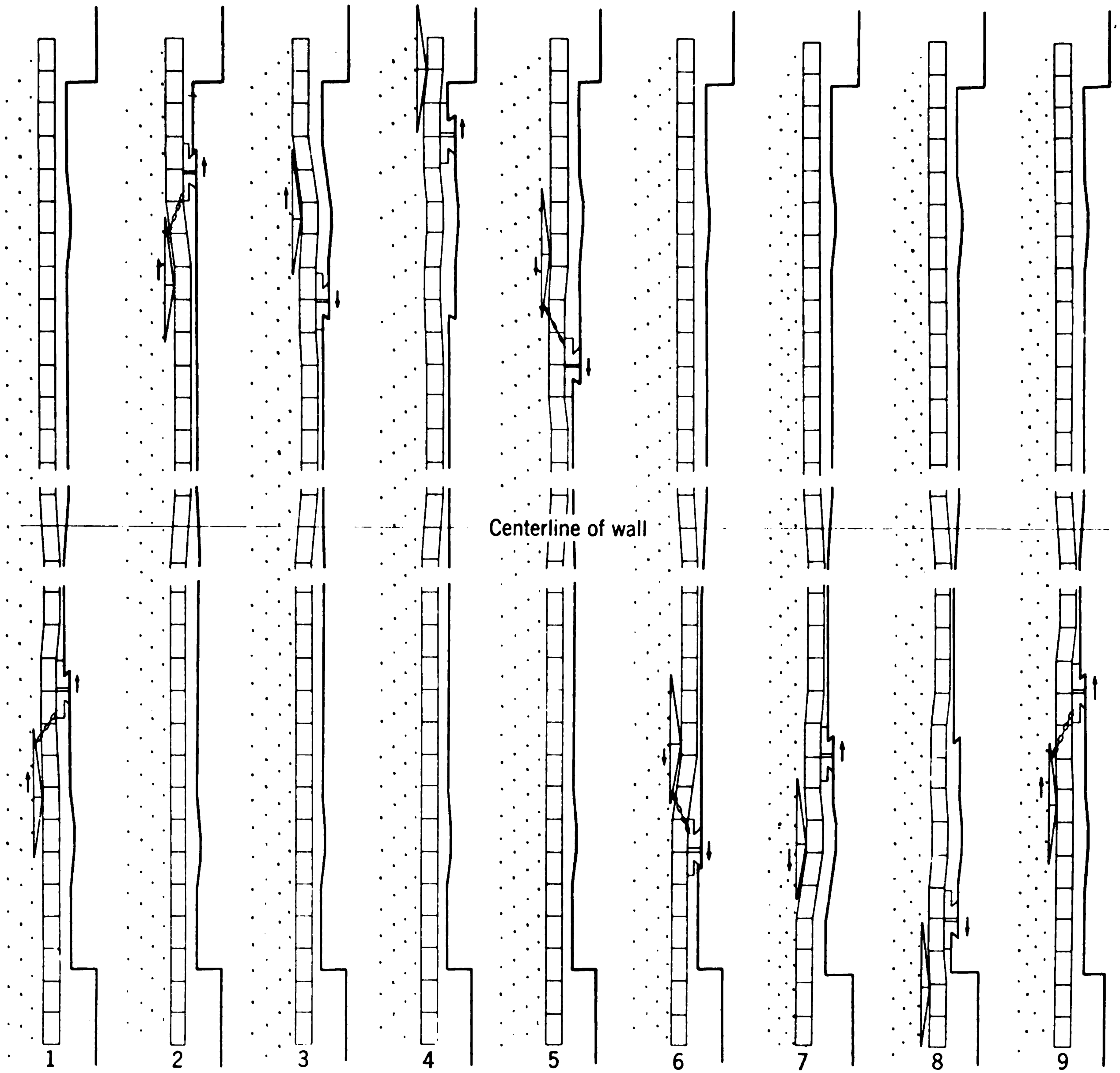


Figure 21. - Sequence of cuts, Friedrich-Heinrich mine.

METHODS OF OPERATION

Friedrich-Heinrich Mine

In hard coal the planer tends to rise or tip unless the pressure applied against it, to hold it into the cut, can be relieved automatically. As the planer travels in the narrow path between the conveyor and the coal face, the conveyor must be moved after each planer cut. One form of moving device is the pneumatic pressure cylinder or ram (fig. 20). Rams are placed on the mine floor between the conveyor and props and 4 to 5 meters (13 to 16½ ft.) apart. As each cut is completed, the conveyor is moved sideways by an amount approximately equal to the depth of a full planer cut. The rams also serve to hold the conveyor in position as the planer passes, and these retract automatically if the planer needs relief.

A second form of conveyor-moving device in use at the Friedrich-Heinrich mine is the backsled, or wedge-shaped skid, which is dragged along by the planer between the conveyor and the face row of props. This moves the conveyor sideways but does not provide for holding. To obtain the necessary planer holding pressure, the conveyor is moved toward the face a distance greater than the depth of planer cut; on the return trip the planer is crowded, or wedged, and thus is forced into the coal unless the resistance of cutting is greater than the force necessary to move the conveyor toward the gob, in which case the conveyor is moved and holding pressure is automatically relieved.

The planer in use is designed for a full cut of 30 centimeters (12 in.); the width of the backsled is 40 centimeters (15-3/4 in.). The sequence of operations provides for one cut of 30 centimeters (12 in.) followed by a cut of 10 centimeters (4 in.) on the return trip - an average of 20 centimeters (8 in.) for one full round trip.

The nine phases of operation for making one round trip with a planer having a blade holder 30 centimeters wide and a 40-centimeter wide backsled (fig. 21; nos. 1 to 9) are as follows:

1. The planer cuts 30 centimeters in traveling from the lower road to the middle of the wall. As the planer path between the conveyor and the wall is but 20 centimeters, the planer shoves the conveyor 10 centimeters toward the gob in soft coal and as much as 20 centimeters in hard coal. The 40-centimeter blacksled moves the conveyor into its old position, and timbering is carried on after it has passed.

2. In traveling from the middle of the wall to the upper road, the planer is in a previously cut path, cleans this up, and at the same time cuts 10 centimeters. The backsled then moves the conveyor 40 centimeters towards the wall.

3. After the planer reaches the upper end of the wall, the backsled is detached, and the planer is pulled down the wall below the backsled and is stopped as soon as it passes. The backsled is then pulled through to the upper end, so that it can assume its normal position for travel downward. The upper drive end of the conveyor is moved 40 centimeters.

4. The planer is then pulled towards the top road and, traveling along the reset conveyor, cuts 30 centimeters.

5. After attaching the backsled, the planer is made to travel down the wall, repeating the 30-centimeter cut and the 10- to 20-centimeter displacement of the conveyor, as in figure 21, number 1.

6. In traveling downward from the middle of the wall, the planer cleans up loose coal and cuts 10 centimeters. The backsled travels between the chain conveyor and the props that were placed when the planer traveled from the middle of the wall to the upper road, and moves the conveyor 40 centimeters towards the face. (Timbering the upper half of the wall is in progress.)

7. After the planer reaches the lower road, it passes by the backsled in traveling into the new cut. The backsled is moved to the lower end of the wall, and the conveyor drive is then moved 40 centimeters.

8. After the lower part of the chain conveyor has been moved 40 centimeters, the planer is pulled to the lower end of the wall and cuts 30 centimeters. The backsled is again attached and the upward trip begins.

9. During the time of travel of the planer from the middle of the wall to the lower road and back again, timbering on the upper half of the wall is completed.

Ibbenbüren Mine

At this mine the conveyor is moved a full 30 centimeters with each planer cut (½ cycle of planer travel) by means of pneumatic pressure cylinders or rams. The piston diameter of the ram is 250 millimeters (10 in.), and the piston rod is 2.2 meters (7 ft.) long; air pressure is 4 to 5 atmospheres (60 to 75 lb. per sq. in.). The desired cushioning effect is obtained automatically by using air cylinders with piston rods slotted every 12 inches for inserting a steel key, which limits the retraction.

The conveyor drive heads are fastened to the main-sheave frame (fig. 18) and are moved with it after each planer cut.

ROOF SUPPORT

Backfilling or caving may be practiced with coal-planer operation (figs. 17 and 22). In following a saw-blade timbering system (figs. 23a, 23b, 23c, and 23d), every third or fourth line of props and caps is advanced as planing progresses, and in this way close face timbering is maintained. The front props, against which the backsled rides, may be braced with wood (fig. 23a).

At the Ibbenbüren mine, in planing hard coal, pneumatic packing with wood props and wedges is followed successfully in freeing the coal by means of roof pressure.

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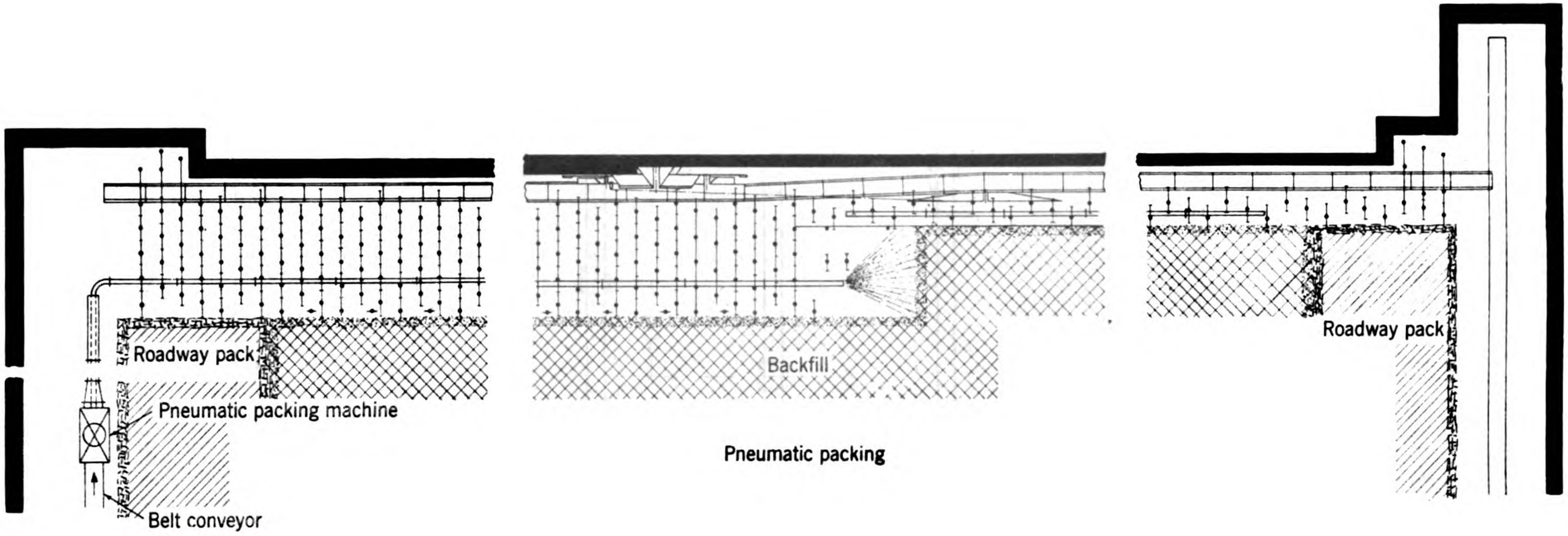
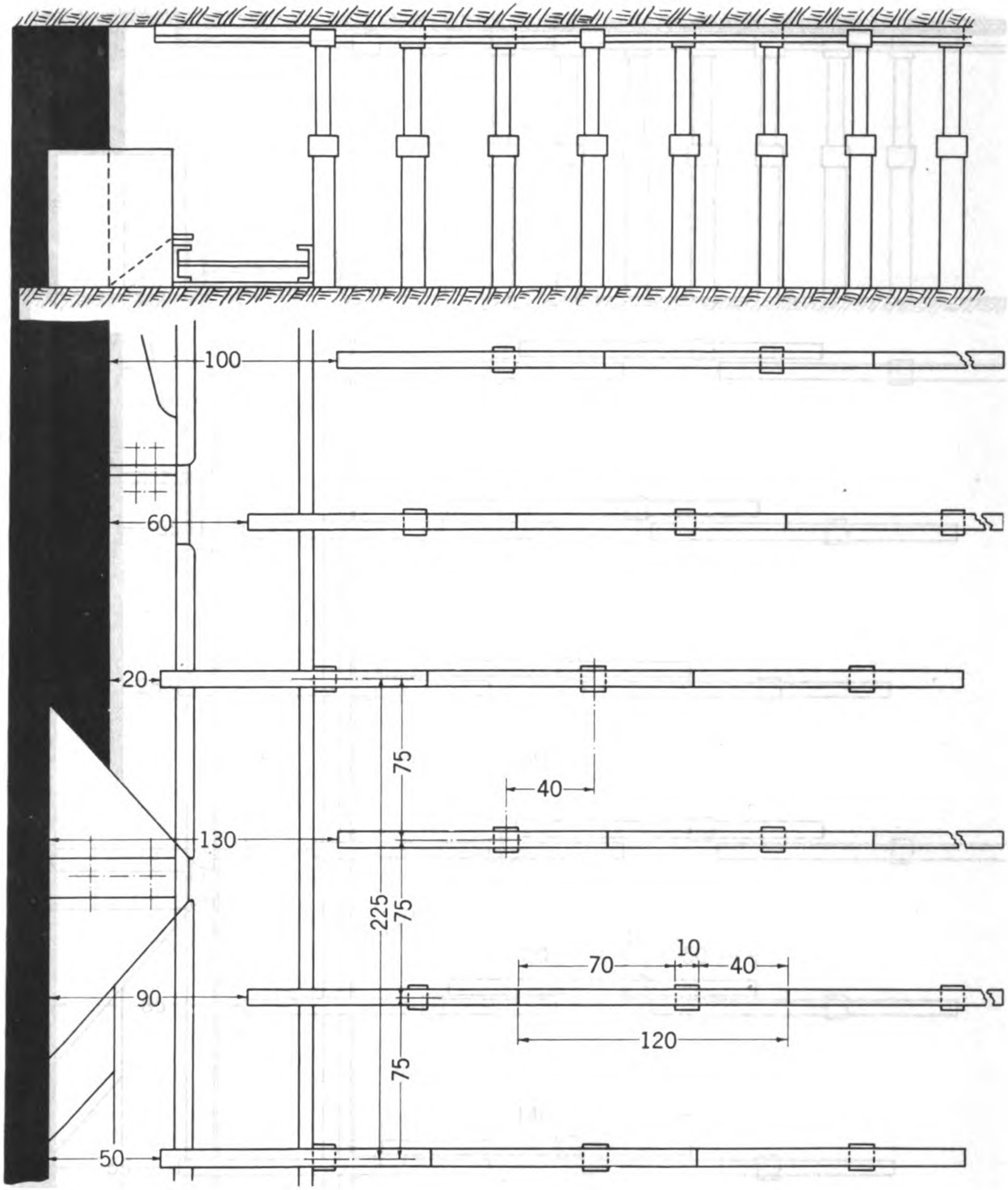
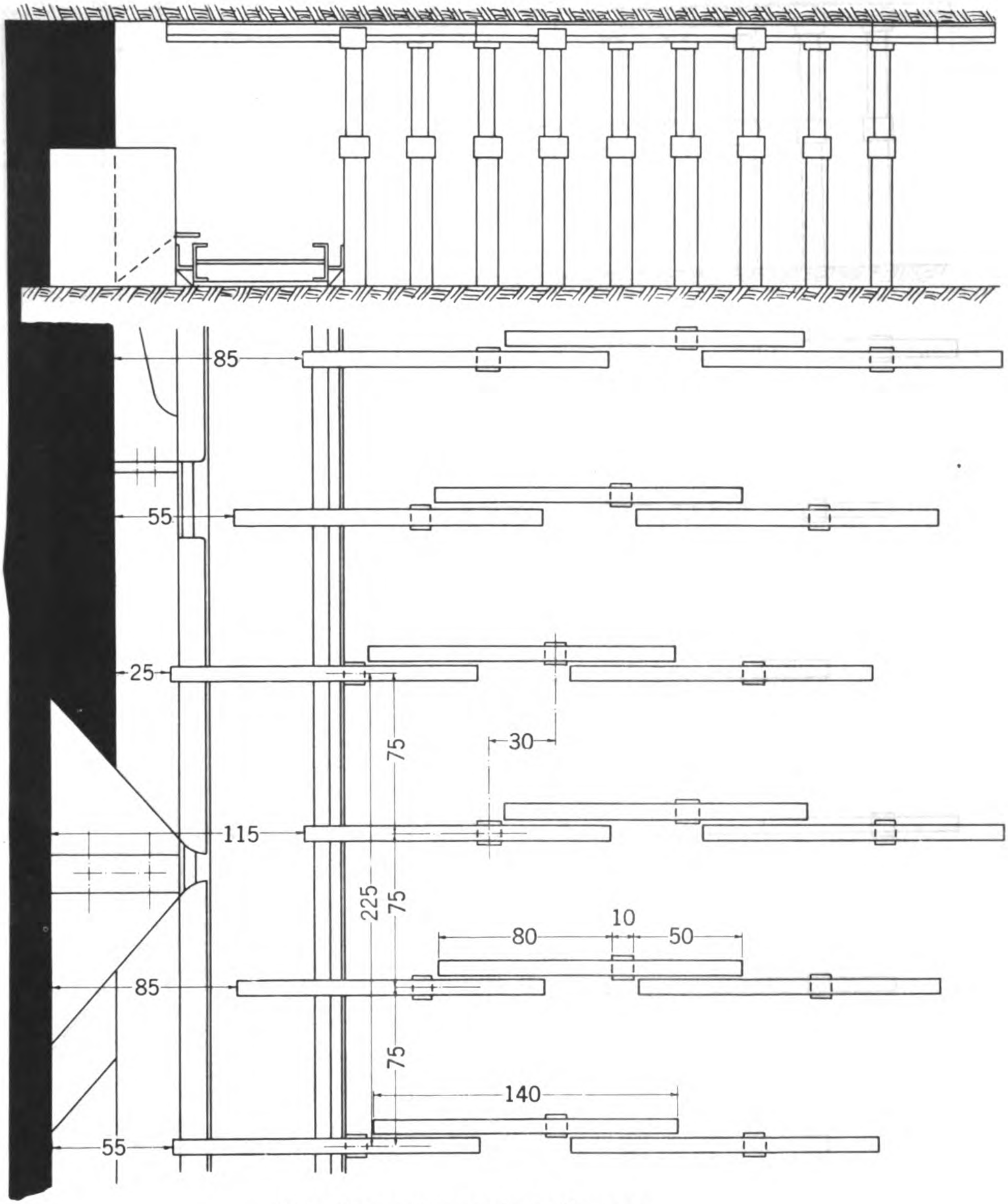


Figure 22. - Pneumatic packing with coal planer, Friedrich-Heinrich mine.



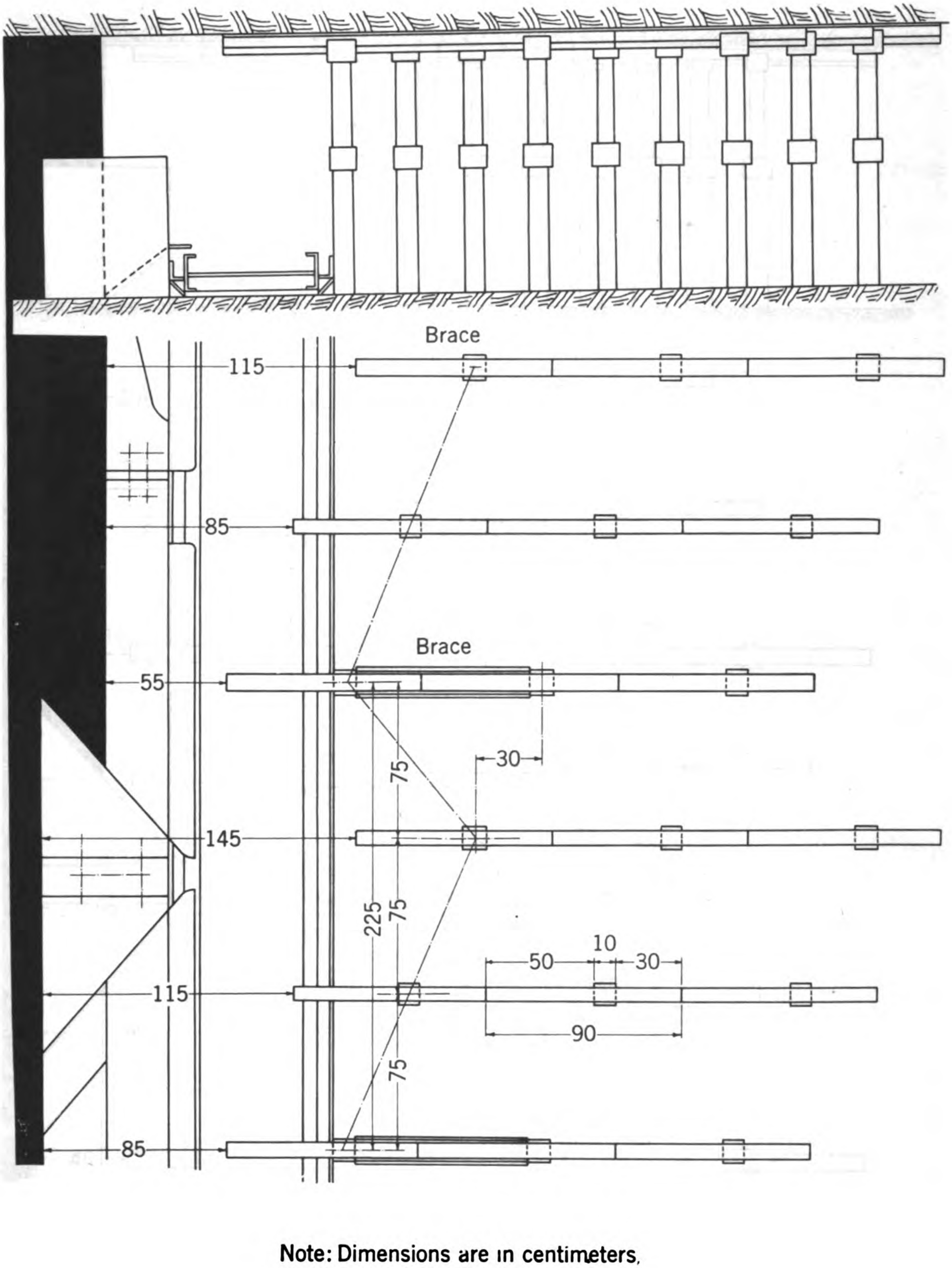
Note: Dimensions are in centimeters

Figure 23a. - Saw-blade timbering with coal planer, Friedrich-Heinrich mine.



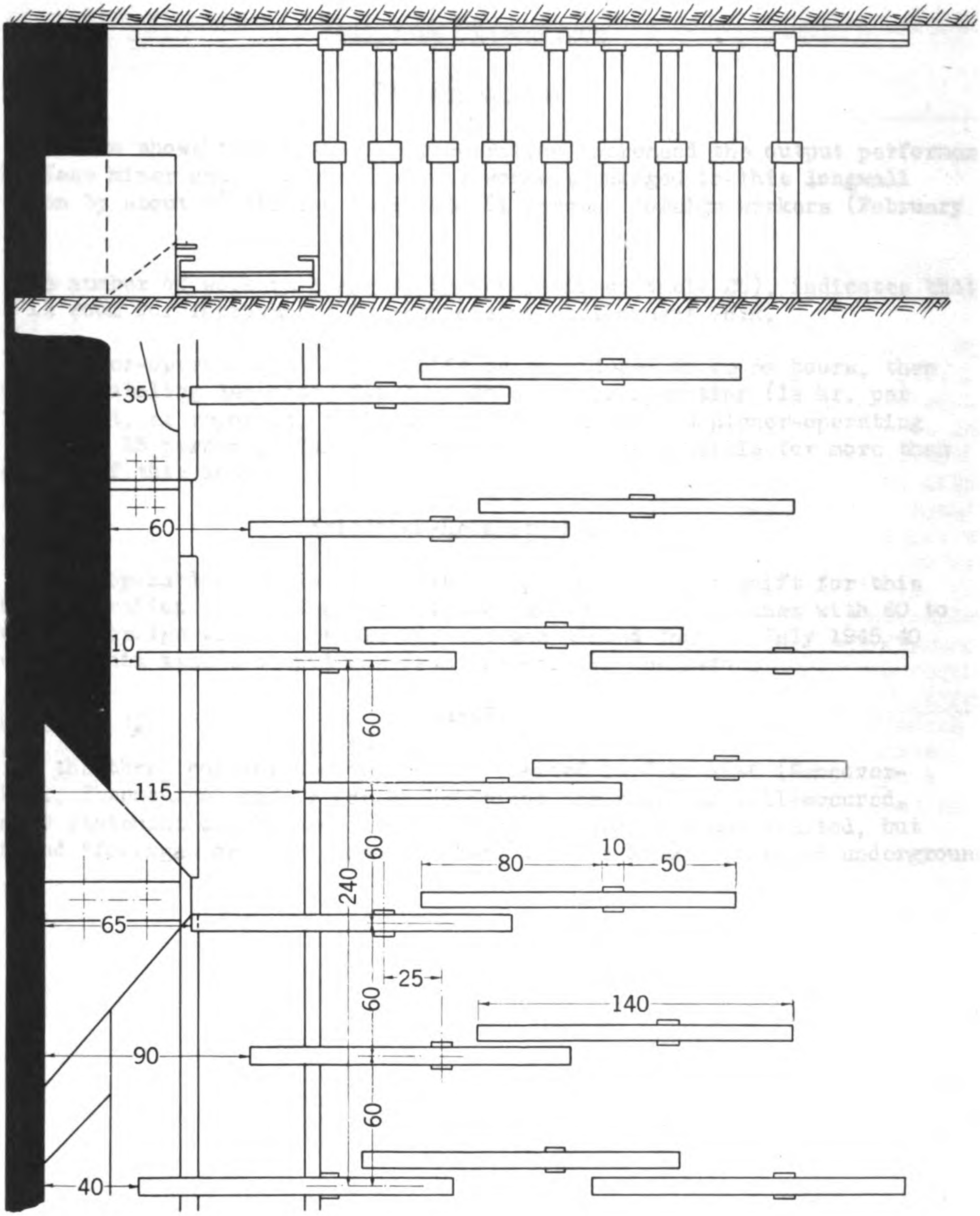
Note: Dimensions are in centimeters

Figure 23b. - Saw-blade timbering with coal planer, Friedrich-Heinrich mine.



Note: Dimensions are in centimeters.

Figure 23c. - Saw-blade timbering with coal planer, Friedrich-Heinrich mine.



Note: Dimensions are in centimeters

Figure 23d. - Saw-blade timbering with coal planer, Friedrich-Heinrich mine.

OPERATING PERFORMANCE

Ibbenbüren Mine

Table 2a shows that coal-planer operation increased the output performance of the face miner and helper and of all workers engaged in this longwall operation by about 2½ times - this with 61 percent foreign workers (February 1945).

The number of workers engaged, by occupations (table 2b), indicates that there is room for improvement by mechanizing development work.

If planer-operating time per shift is considered to be 5½ hours, then the delays totaling 34½ hours for 1 month's planer operation (1½ hr. per loading shift, as reported, table 2c) indicate a loss in planer-operating time of over 25 percent. Conveyor breakdowns are responsible for more than 50 percent of this loss.

Friedrich-Heinrich Mine

Planer operation has increased the output per man per shift for this longwall operation, excluding backfilling, by nearly three times with 60 to 70 percent foreign workers (table 3). It was stated that in July 1945, 40 percent of this mine's output was from coal-planer operation.

SAFETY

At the three coal-planer operations visited in July 1945 (Hannover-Hannibal, Ibbenbüren, and Friedrich-Heinrich) the roof was well-secured. The same statement can be made about all other working faces visited, but unskilled "foreign workers" (forced labor) were no longer employed underground.

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TABLE 2a. - Comparison of conventional pneumatic-pickhammer method for flat-bed, advancing-longwall mining and coal-planer method, Oeynhausen mine, Ibbenbüren, Ruhr

Items compared	Conventional longwall pneumatic pickhammers, 12-month average, 1941	June 1942	July 1942	August 1942	September 1942	February 1945 1/
Bed mined............	Glücksburg	Glücksburg	Glücksburg	Glücksburg	Glücksburg	Glücksburg
Total bed thickness... ....inches	39	53	48	46	46	35
Refuse (top slate).do.	5	14	10	8	8	4
Coal..............do.	34	39	38	38	38	31
Pitch.........degrees	1 - 4	1 - 4	1 - 4	1 - 4	1 - 4	1 - 4
Length of face assigned to each miner or helper........feet	12.2	14.1	11.7	11.8	12.0	20.3
Face advance per workday (24 hours)...feet	4.8	8.4	9.6	11.2	10.8	7.9
Production performance: Longwall operation, 2/ output per man per shift........net tons	3.85	7.37	8.46	9.72	9.55	7.30

1/ Sandstone conglomerate roof; smooth slate floor; props on 4- to $4\frac{1}{2}$-foot centers; compressed-air backfilling (130 net tons per shift); wall, 223 feet; 61 percent foreign workers.

2/ Includes development, backfilling, and equipment maintenance.

TABLE 2b. - Number of men and percent, by occupations; and output per man per shift, 1945 practice for a 230-foot face (fig. 18) and a 3-foot bed

Occupations	Men employed				Output per man per shift, in net tons[1]	
	Number	Percent	Cumulative total, men employed	Cumulative total, percent	Minimum	Maximum
Planer operation:						
Miners on longwall	10	-	-	-	-	-
Miners preparing stalls for sheave frame	6	-	-	-	-	-
Planer-hoist operators	2	-	-	-	-	-
Breaking lumps of coal (pneumatic pickhammers)	2	-	-	-	-	-
Total	20	31.3	20	31.3	8.25	10.25
Pneumatic packing	10	15.6	30	46.9	5.50	6.84
Maintenance:						
Pipemen and machinists	3	4.7	33	51.6	5.00	6.21
Development:						
Top and bottom roads	18	28.1	51	79.7	3.23	4.02
Transportation:						
Timber and supplies	2	-	-	-	-	-
Coal and rock	11	-	-	-	-	-
Total	13	20.3	64	100.0	2.58	3.20

[1] Output per 24-hour day 165 to 205 net tons, calculated, based upon average performance data.

TABLE 2c. - Delays at single planer operation for one month, which interrupted normal operation

Reason for delay	Time lost (hours)
Planer climb	2
Loosened winches and broken ropes	4
Face-conveyor breakdowns	18
Main-conveyor breakdowns and main-road roof falls	4
Bad roof on longwall	3
Electrical supply failures	3-1/2
Total delays	34-1/2

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TABLE 3. - Comparison of conventional pneumatic-pickhammer method for flat-bed, advancing-longwall mining and coal-planer method, Friedrich-Heinrich mine, Lintfort, Rheinland

Items compared	Conventional longwall average, 3 mos., 1940	Coal-planer method			
		January 1944	February 1944	March 1944	Average, 3 mos., 1944
Bed mined	President	President	President	President	-
Bed thickness	5'-7"	5'-11"	5'-11"	5'-11"	5'-11"
Pitch ... degrees	2 - 5	1 - 2	1 - 2	1 - 2	1 - 2
Length of face ... feet	1,000	670	670	660	670
Number of props per square foot of exposed roof area	0.112	0.103	0.103	0.103	0.103
Face advance per month ... feet	74	161	162	190	171
per day ... do.	3.0	6.0	6.0	6.6	6.2
Production per month ... net tons	16,652	23,486	24,298	28,212	25,332
per day ... do.	666	870	900	973	916
Backfilling material placed,					
per month ... cars[1]	10,166	16,961	18,503	20,501	18,655
per day ... do.	407	628	685	707	673
Production performance:					
Longwall operation, excluding backfilling and development, output per man per shift - net tons[2]	11.5	28.5	30.9	32.9	30.8
Longwall operation, including backfilling and excluding development, output per man per shift - net tons[2]	8.7	15.7	16.8	18.1	16.9
Longwall operation, including backfilling and development, output per man per shift - net tons[2]	7.9	10.1	11.9	12.7	11.8

[1] Car content, 31 cubic feet broken material.

[2] Calculated from statement showing number of shifts required per 100 metric tons production.

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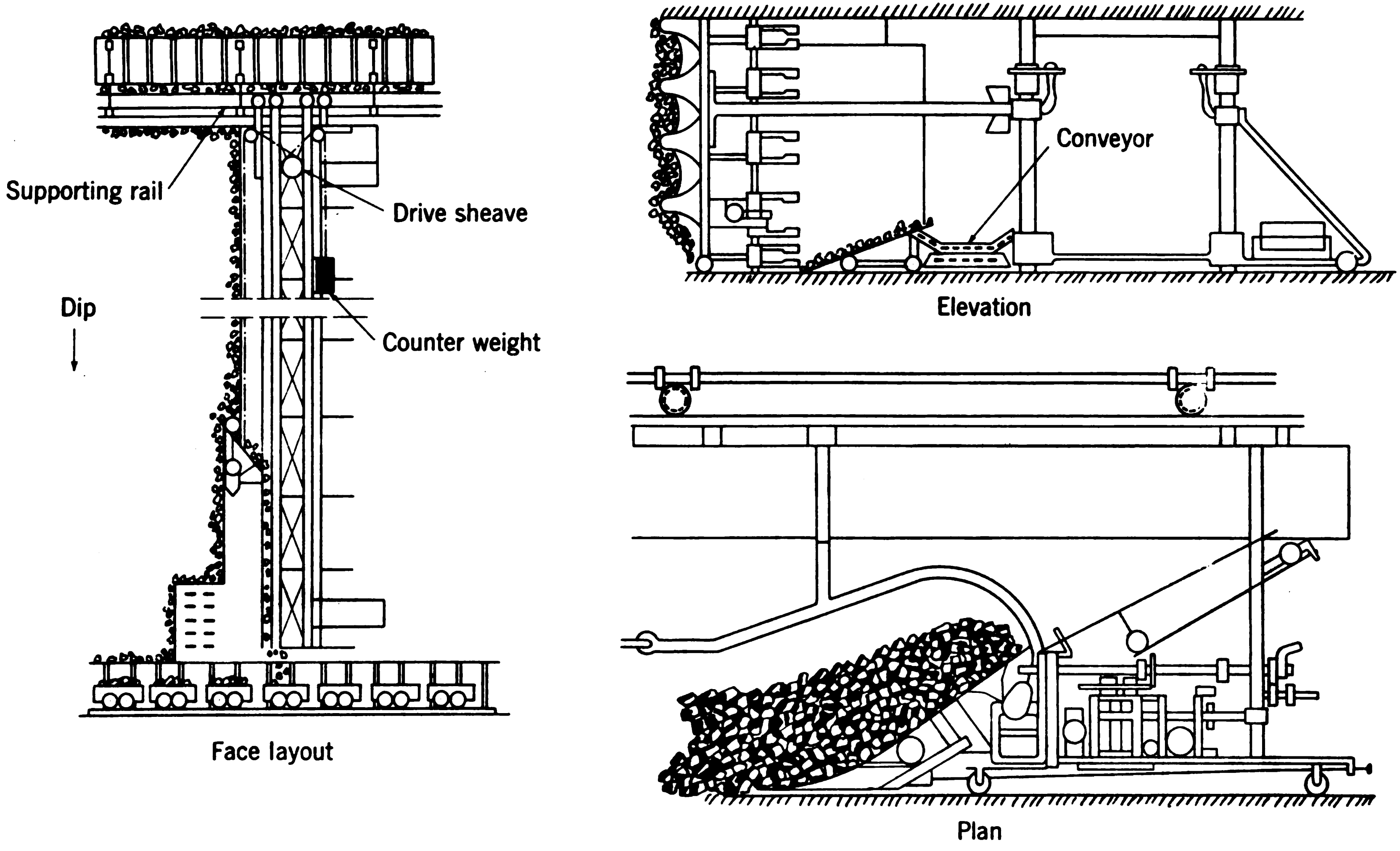

Figure 24. - German patent, 1912.

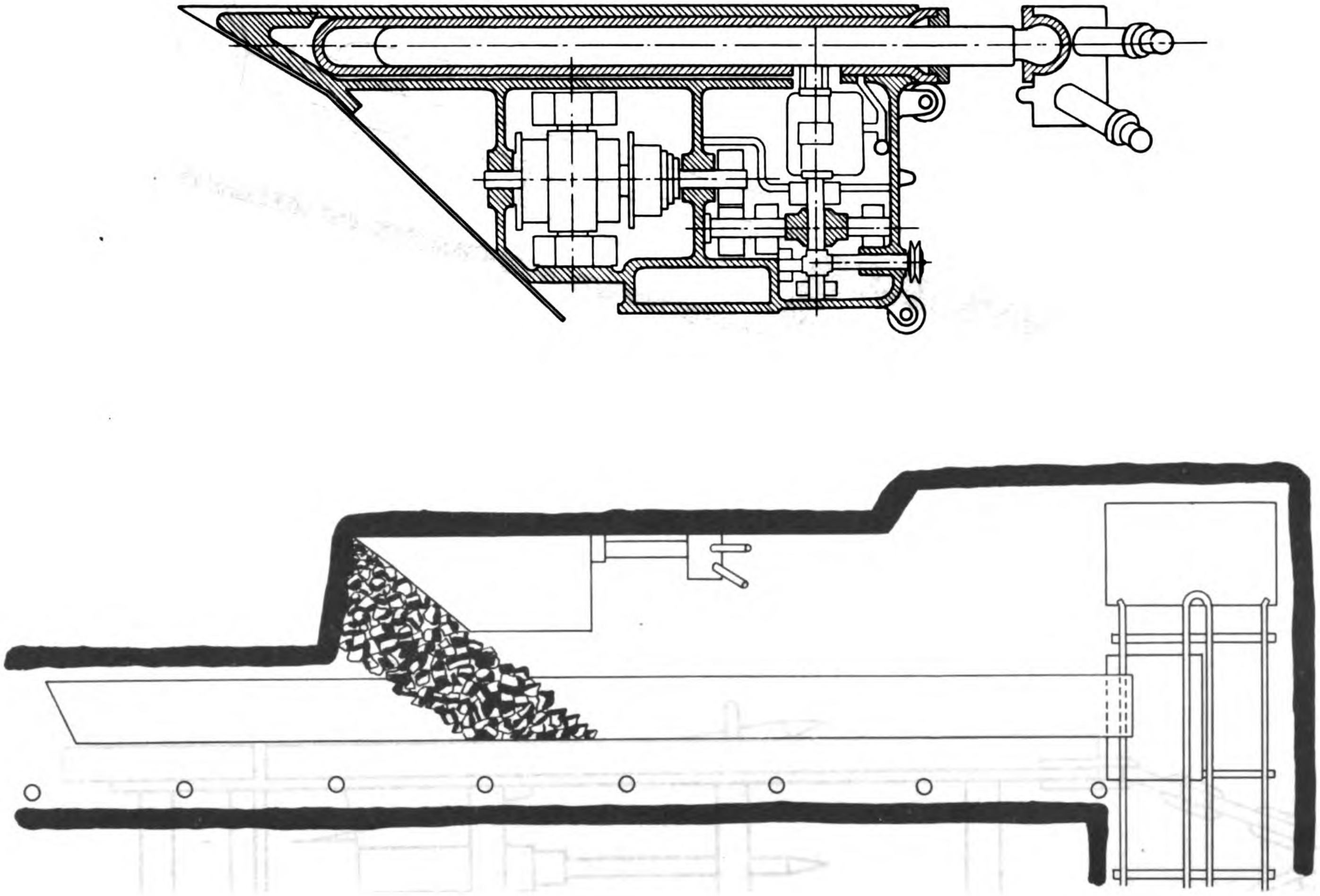

Figure 25. - British patent, 1917.

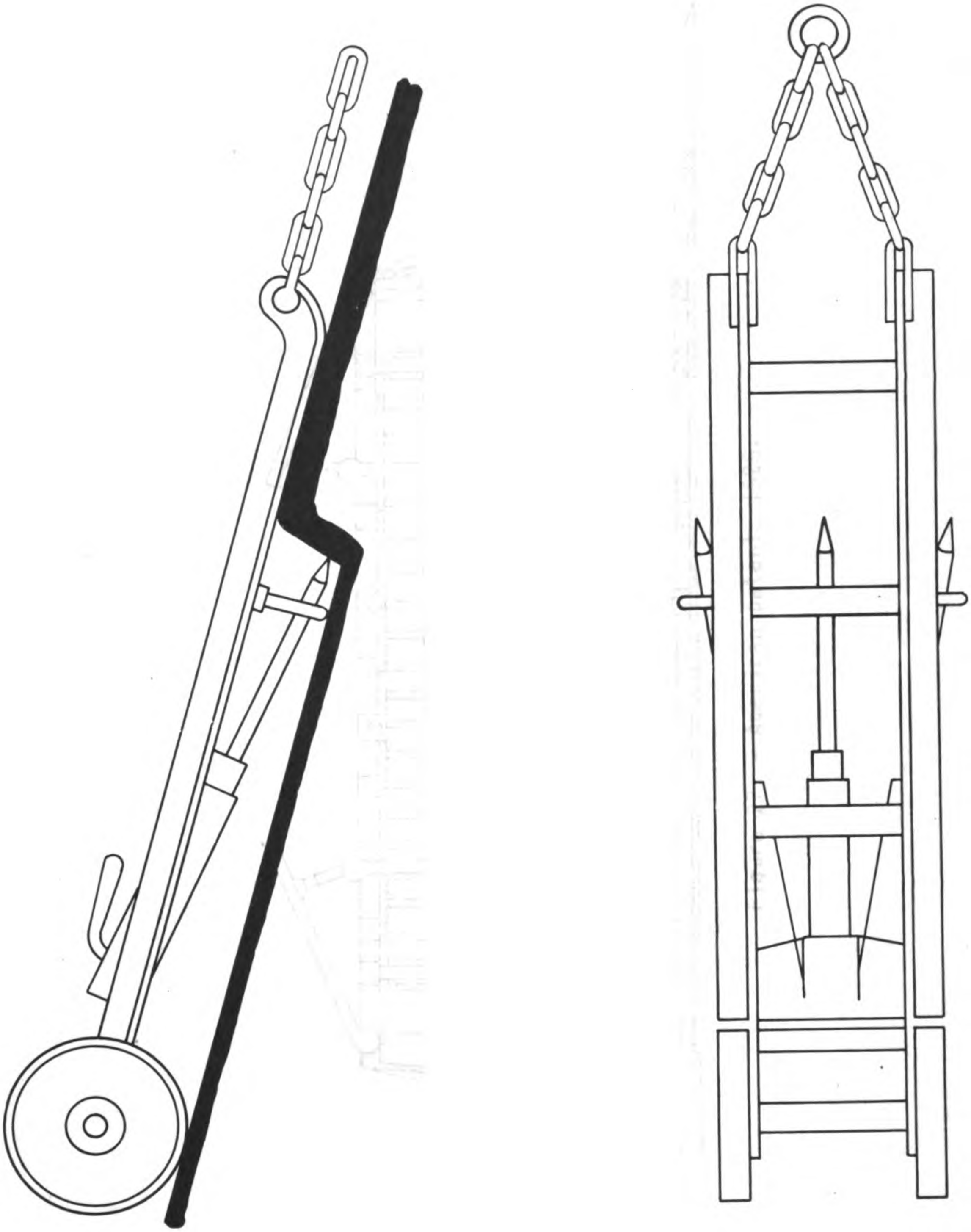

Figure 26. - German patent, 1922.

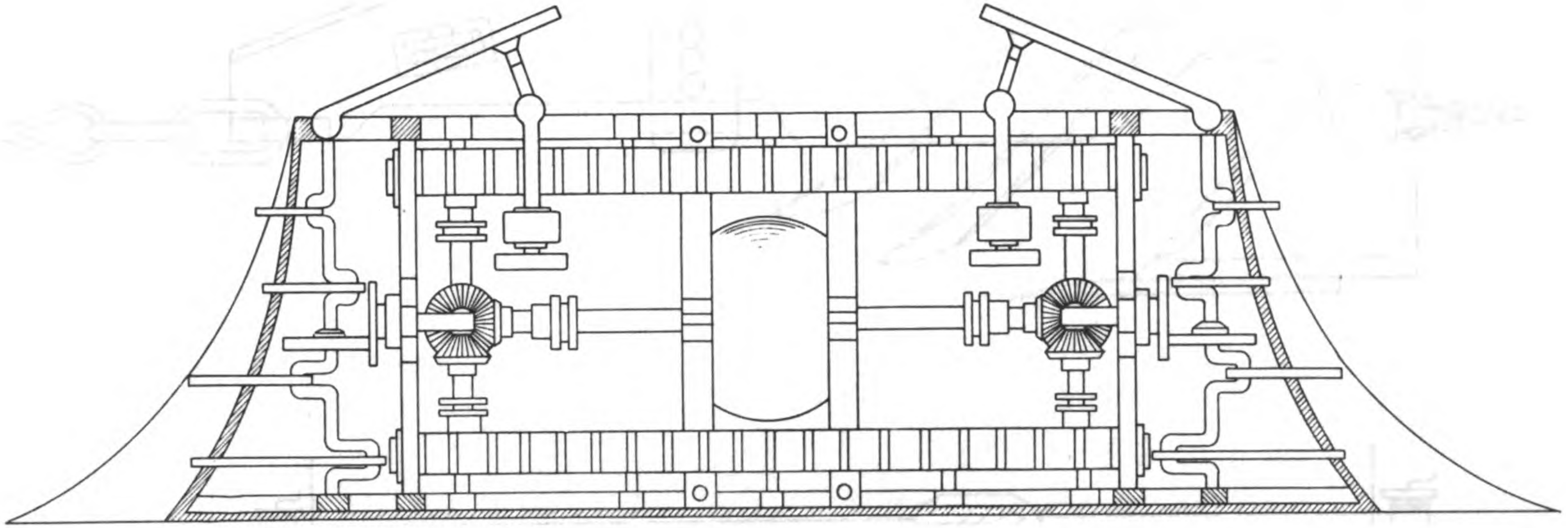

Figure 27. - American patent, 1925.

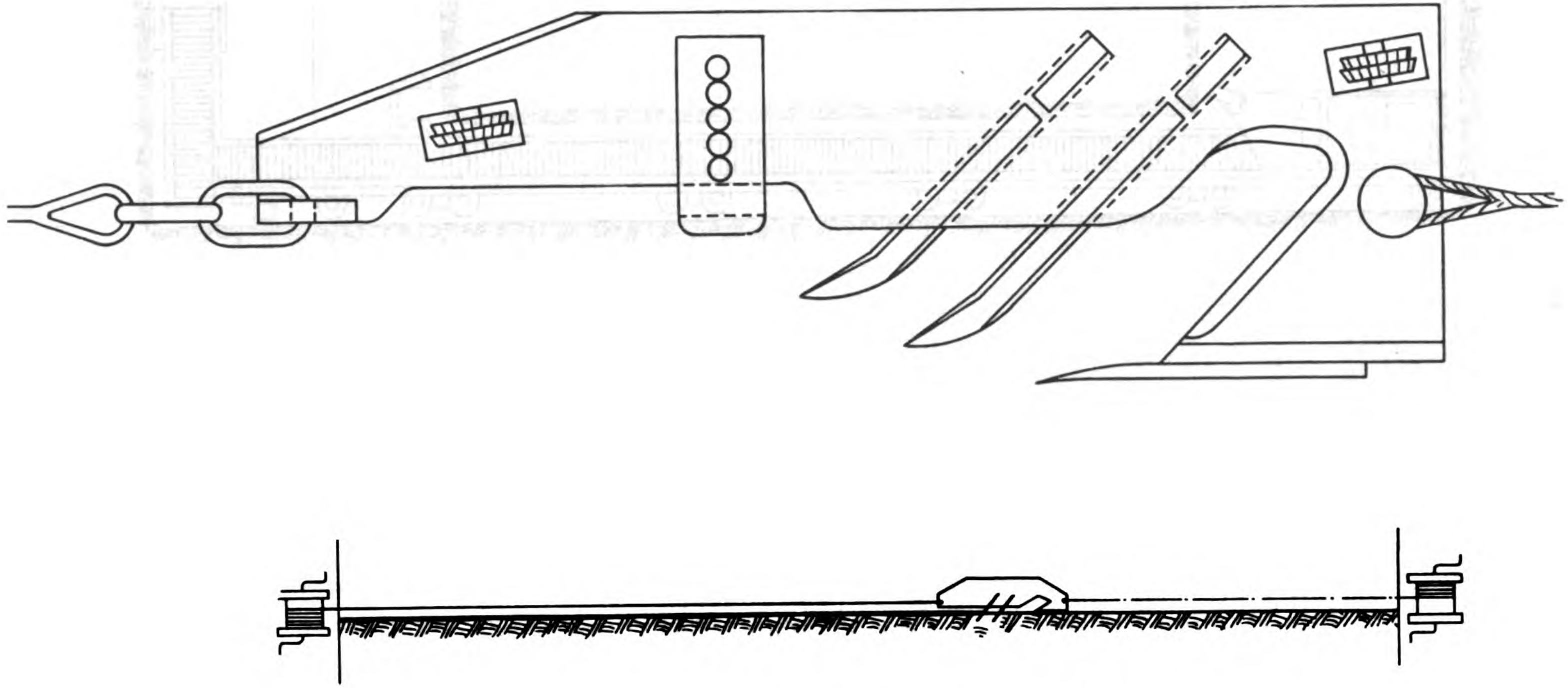

Figure 28. - French patent, 1927.

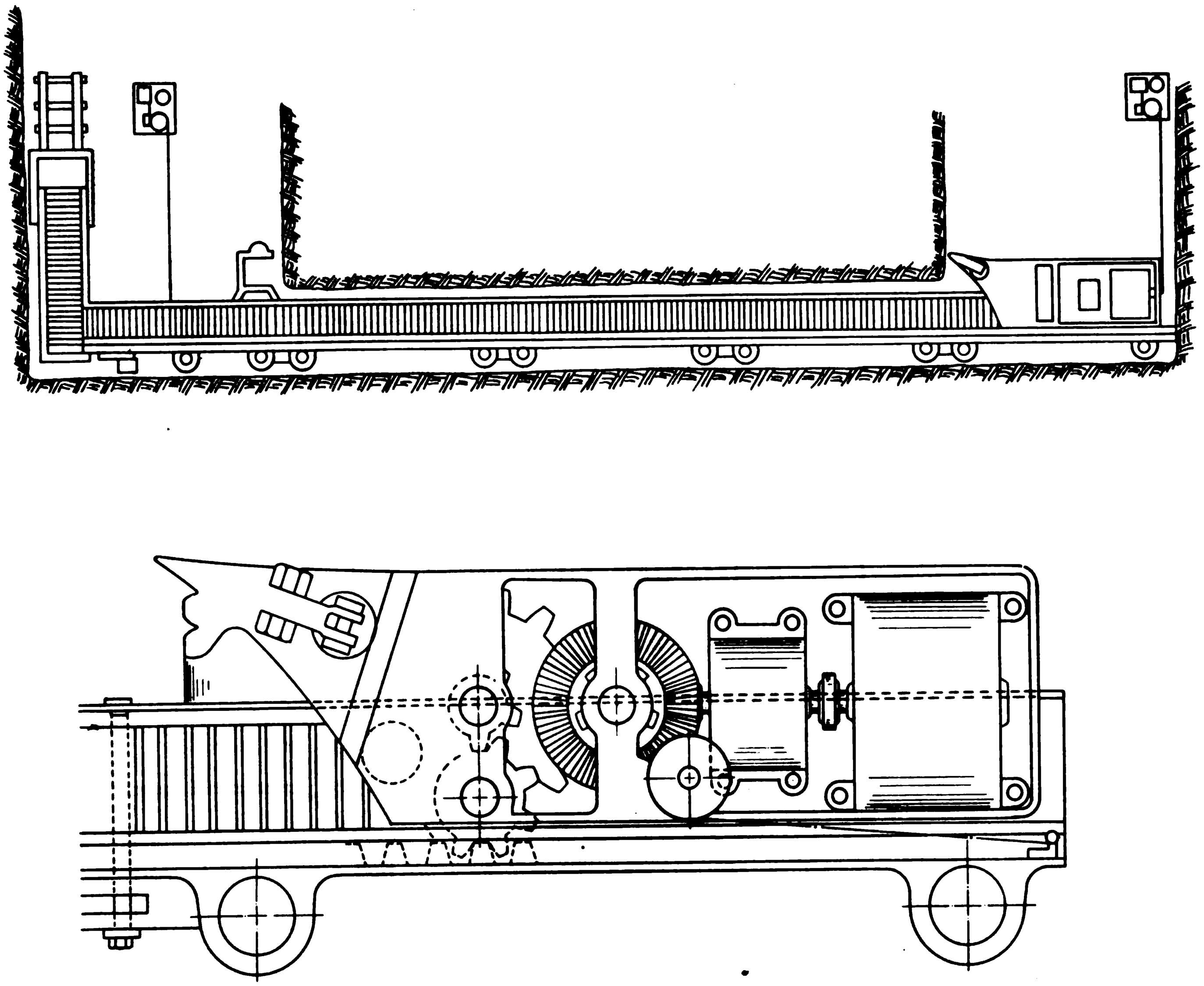

Figure 29. - American patent, 1929.

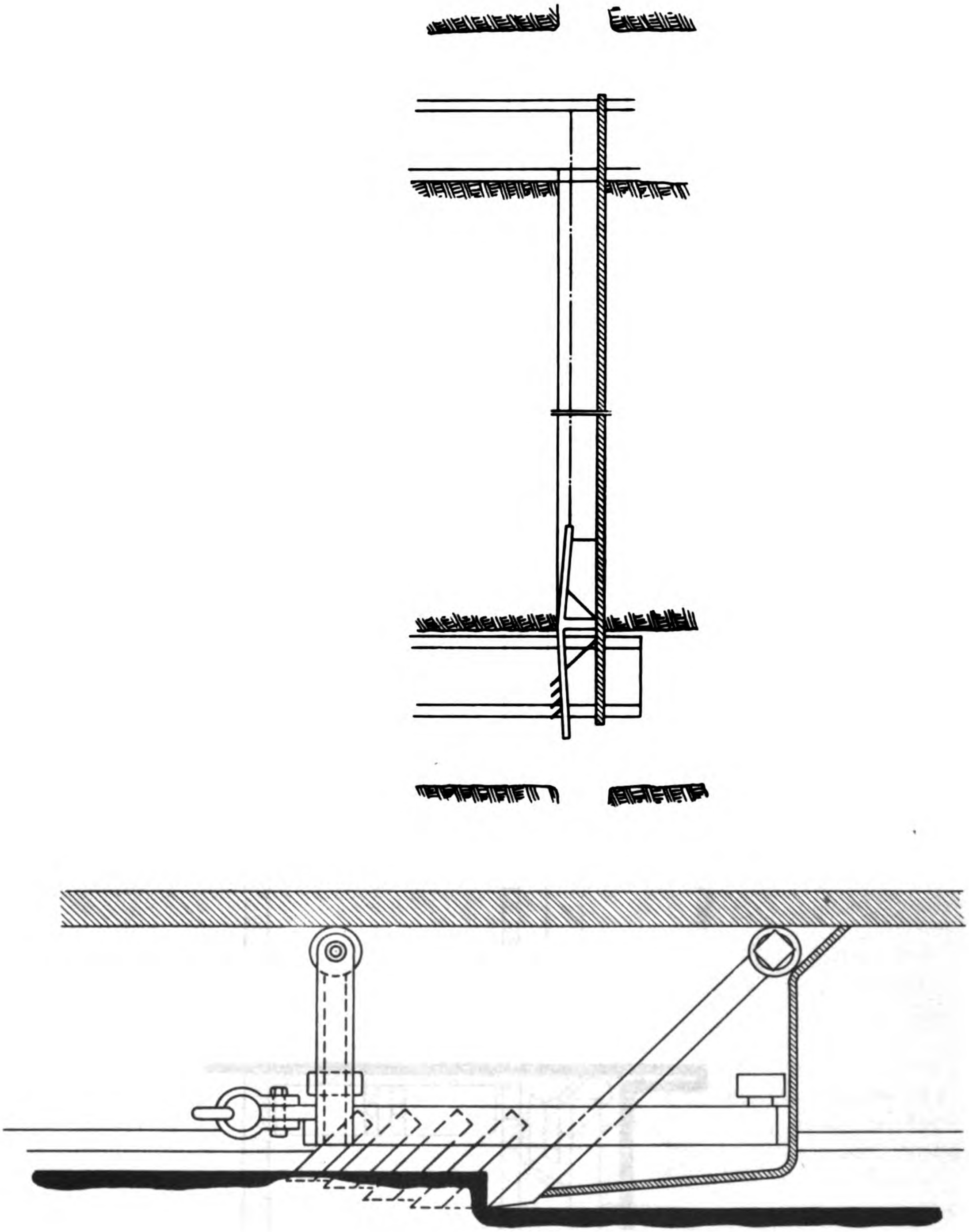

Figure 30. - German patent, 1935.

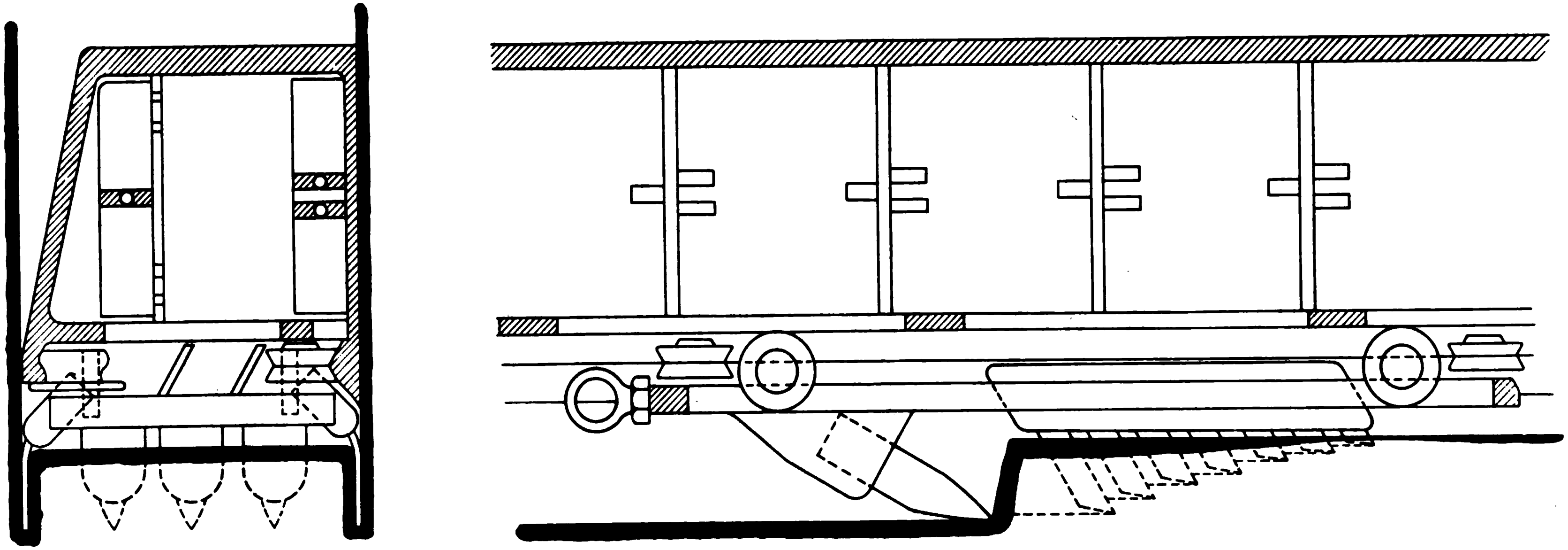

Figure 31. - German patent, 1935.

PATENTS

The following patents and remarks relating to coal-planing devices were recorded by Lange:[5]

1. German patent No. 278,881, year 1912, inventor Wissemann. This device, which in a general way resembles the coal planer, is pulled along the face by a rope. The cutting blade consists of a series of drills combined with a wedge, which strips a cut 40 centimeters deep from roof to floor. The broken coal is forced over a ramp onto a face conveyor (fig. 24).

2. British patent No. 117,552, year 1917, inventor Hirst, describes a hydraulic wedge-shaped shaver-loader (fig. 25).

3. German patent No. 388,264, year 1922, inventor Diancourt, relates to a mobile frame, on which pneumatic chisel bits are mounted for breaking the coal (fig. 26). The expression "planing coal" appears for the first time in this patent.

4. American patent No. 1,563,153, year 1925, inventor Brackett, describes a coal plow mounted on caterpillars. Coal is broken by wedge-shaped cutting blades operated by crankshafts (fig. 27).

5. French patent No. 647,240, year 1927, inventor Ducoeur. The details of this machine and the mine layout for using it closely resemble those for present form of coal planer. The steel frame carries a main cutting blade and two auxiliary blades, which advance ahead of the main blade as the planer is pulled along the face. The angle of the two auxiliary blades aids in keeping the planer in the coal. The purpose of the toothed rollers, set at an angle with the face, is to roll the planer against the coal and to hold it in the cutting position. This is a two-direction planer (fig. 28).

6. American patent No. 1,710,801, year 1929, inventor Morgan, describes a shaving machine that travels along a rack rail built into the conveyor. Cuts are several inches deep, and the coal is loaded into the conveyor (fig. 29).

7. German patent No. 635,532, year 1935, inventor Hamel, describes a box onto which wedge-shaped blades are mounted for ripping coal as the planer is pulled along the face by means of a rope. The coal passes into the box, which serves as the medium of transportation (fig. 30). This patent, through court proceedings, was found to be worthless, because the basic principles for planing coal were known.

8. German patent No. 642,686, year 1935, inventor Hamel, describes a device in which chisel bits are mounted on a steel boxlike roller frame, through which the coal passes onto a conveyor as the planer is pulled along the face (fig. 31).

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STEEP-PITCH MINING

Coal-planer Design

For steep-pitch mining, the Westhausen mine has experimented with a coal planer in which a single blade holder is mounted on two tandem skids having a total length of 17-1/2 feet (fig. 32). Planing is in one direction only - upgrade. The legs that support the planer are adjustable; the skids ride on the top row of props (fig. 33); and the blade holder, or planer proper, must be raised for each new cut. The number of such adjustments depends upon the depth of each cut and the prop-line interval. Depth of cut in the original design was 4-3/4 to 5-1/2 inches, and the width approximated one-third the bed thickness. A second design employed a cut of the same depth, but the width of the blade was increased to one-half the bed thickness. A still later design cut to a depth of 30 centimeters (12 in.).

The Furtenhofer planer (fig. 34) consists of two cutting blades mounted on pivoted cross supports which may be extended upward against the coal face. Depths of cut range from 10 centimeters (4 in.) to 20 centimeters (8 in.).

With both types of planer described above, no timber can be used against the coal face, and therefore the coal must be self-supporting.

Operation

In the Westhausen method (fig. 33) a cross-pitch advancing-longwall face was established between levels at an angle of 30 degrees with the horizontal. Complete gravity backfilling was followed, and the fill line was maintained parallel to the face and not more than 10 feet below it. The coal-planer skids rested on the face row of props (section A-B), and the planer was pulled upgrade in making each cut. The main pull rope was anchored on the upper road, threaded through the sheave on the sheave-support arm, and passed over a main sheave to the air hoist on the upper road. This hoist was capable of producing a 10-ton rope pull.

After 10 successive cuts, fill was run, and a new line of props was placed. Coal fell to the steel chute that rested on the fill and ran by gravity to the mine-car loading pocket. The planer did not remove coal on the downward trip, but a hoist was necessary to return the coal planer to its starting position.

A cross section of the coal measures on section 7E between levels and the general position of the longwall face over a continuous operation period are shown in figure 33.

Operating Performance

In table 4, which is an early comparison of coal-planer operation and the conventional stepped-face hand method, the decrease in the number of man shifts required to mine 100 tons of coal, including timbering, is 4.6 or a decrease of 25.0 percent in favor of the coal-planer method.

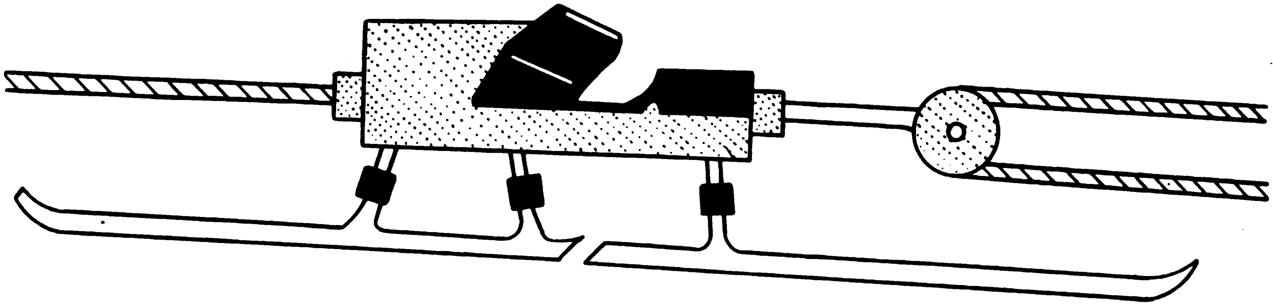

Figure 32. - Westhausen planer.

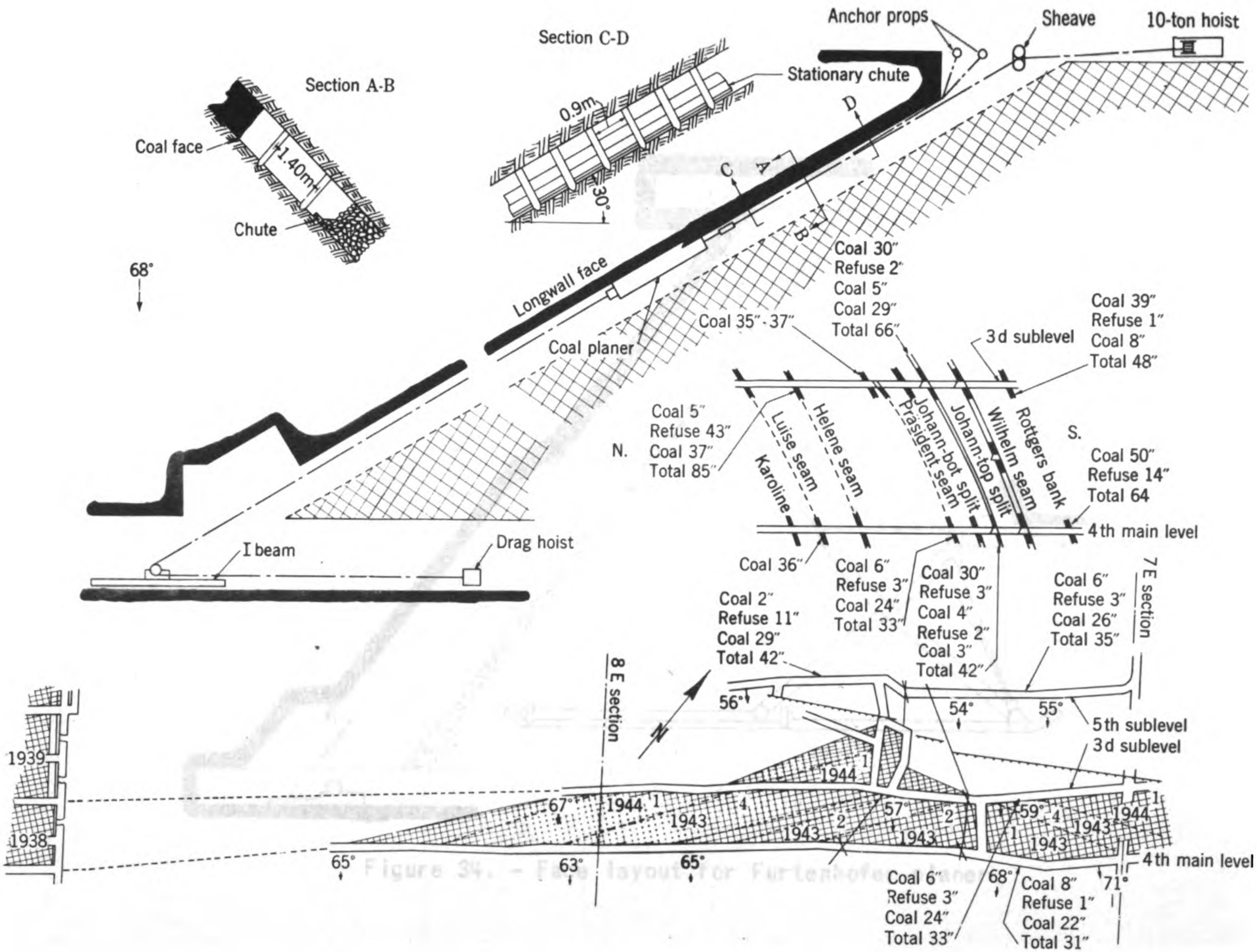

Figure 33. - Face layout, coal planer on steep pitch, Westhausen mine.

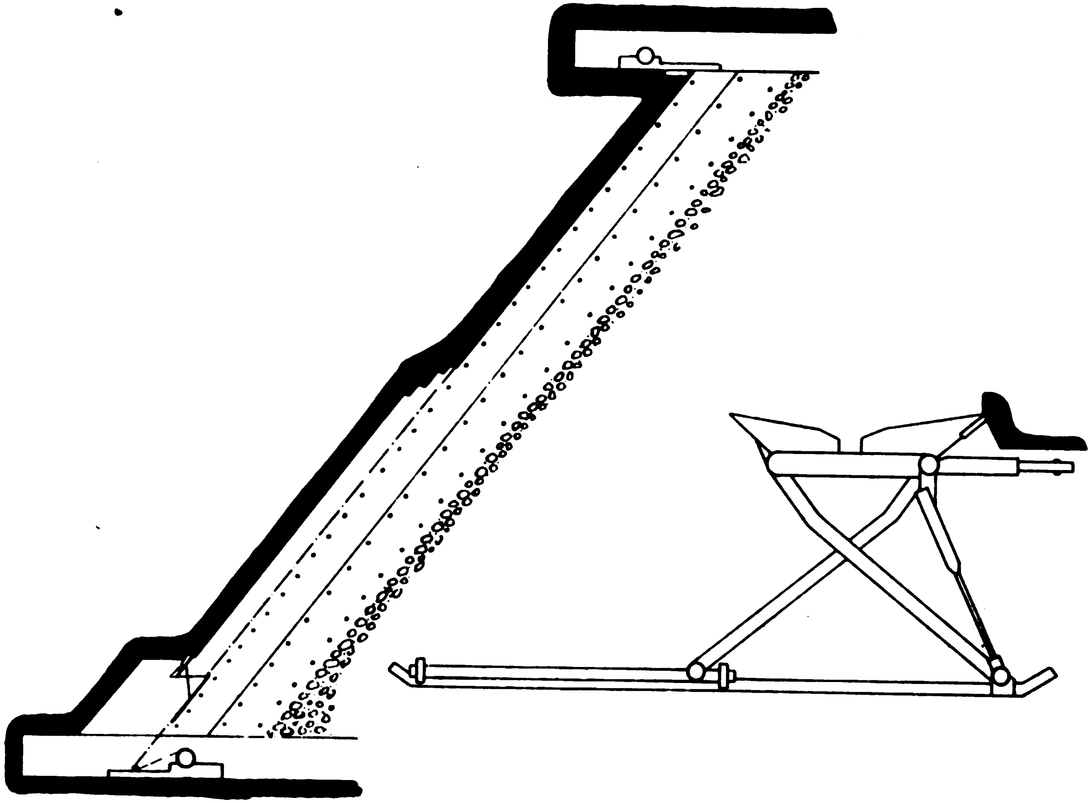

Figure 34. - Face layout for Furtenhofer planer.

TABLE 4. - Comparison of conventional pneumatic pickhammer method for thin-seam, heavy-pitch mining and experimental work with the coal planer, Westhausen mine, Gelsenkirchener Bergwerks, A. G., Dortmund, Ruhr

Items compared	Comparative wall, stepped-face method, pneumatic pickhammers	Coal planer test wall, slant-face method (fig. 33)				Difference	
		January 1943[1]	February 1943[1]	March 1943[1]	Average, three months	In favor of conventional method	In favor of coal planer (fig. 33)
Bed mined	President	President	President	President	President	-	-
Location	Section 5E Levels 1-3W	Section 7E Levels 1-3W	Section 7E Levels 1-3W	Section 7E Levels 1-3W	Section 7E Levels 1-3W	- -	- -
Bed thickness .... inches	42	33	35	35	34	Bed thichness, 8 inches greater	-
Pitch .... degrees	60	65	65	65	65	-	-
Length of wall .... feet	360	360	360	360	360	-	-
Monthly production, net tons	2,365	1,420	1,580	1,720	1,575	790	-
Performance, man-shifts per 100 net tons production:							
Mining coal and timbering	18.4	15.1	13.6	12.6	13.8	-	4.6
Loading coal, dumping backfill, and transporting timber	4.9	4.4	4.4	4.5	4.4	-	0.5
Backfilling	2.2	2.9	3.0	2.5	2.8	0.6	-
Total, excluding development	25.5	22.4	21.0	19.6	21.0	-	4.5
Development	4.4	6.1	5.6	4.8	5.5	1.1	-
Total, including development	29.9	28.5	36.6	24.4	26.5	-	3.4
Production per 24-hour day, excluding developments, net tons[2]	90	54	57	61	57	33	-
Number of men employed, excluding development	23	-	-	-	12	-	-
Output per man per shift, excluding development, net tons[2]	3.92	4.46	4.76	5.10	4.76	-	0.84

[1] Typographical error in documents indicates the year might have been 1944. [2] Calculated.

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Immediately following the test period, the daily face advance was increased from 32 inches per 24-hour day to 48 inches, an increase of 50 percent in rate of advance, with a corresponding increase in tonnage to a figure approximating the 2,365 tons obtained with the conventional method used as the basis of comparison for the test. No data are available on the performance of the newest design with the 30-centimeter (12-in.) cut.

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The author wishes to acknowledge the assistance of George H. Krauss,[12] translator, and of Walter L. Herold,[13] consulting engineer, in translating and evaluating German documents relating to design and operation of the coal planer.

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